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DOMESTIC ELECTRIC LIGHTING.

A LARGE section of our readers will read with special satisfaction the interesting communication in our other columns on electric lighting in private houses, which was brought before us by Mr. A. Rashleigh Phipps. The information given comes at a very opportune moment, and, we should say, is likely to lead to a considerable amount of business in house lighting by electricity. Coming from such a well-known architect as Mr. Phipps, who, we believe, was responsible for the introduction of electric lighting into the Savoy and Prince's Theatres, the tabulated results of 12 months' experience are calculated to inspire increased confidence in the future of this branch of electric lighting, and to that future we shall look with hope.

But notwithstanding our belief in the success of domestic electric lighting, and in the general accuracy of Mr. Phipps's results, there are several points in the statement to which we desire to call attention. In the first place it is perplexing to reconcile the cost of working the engine for 4½ hours per day as given by Mr. Phipps with the results obtained by calculation. Gas in this gentleman's neighbourhood costs 3s. per 1,000 cubic feet, and we doubt very much whether his engine can indicate nearly 2 H.P. with less than 60 cubic feet of gas per hour. This would make the cost per diem nearer ninepence, and, notwithstanding the figures quoted, in which there is probably some overlooked omission, we think our readers will agree that the cost as given by Mr. Phipps is too low. If, however, he can substantiate his published outlay, then so much the better for electric lighting. Another matter for consideration is the durability of the secondary batteries, about which so much doubt has been expressed. We believe that it is chiefly due to the uncertainty existing as to the life of these apparatus that private applications of electric lighting have been so few. Mr. Phipps's experience will do much to remove doubts and allay apprehension on this score. A third matter of the greatest importance is that of lamp economy and life. Mr. A. Rashleigh Phipps, who has had charge of his father's installation, informs us that amongst the many systems tried, the conclusion forced itself upon them that the Woodhouse and Rawson type of lamp was the most satisfactory.

Mr. Phipps is to be commended for his courage in embarking upon an experiment attended with so many risks, and the results of which were involved in so much doubt; and, in the face of his success, we can do no less than advise other gentlemen who have large establishments and who value their books, pictures and decorations, to straightway follow his example.

THE FRANKLIN INSTITUTE INCANDESCENT LAMP TESTS.

IT was with some degree of surprise that we read the strictures of the *Mechanical World* upon the management of the Franklin Institute respecting the tests recently conducted on incandescent lamps—surprise that that usually fair and impartial journal had so far forgotten itself as to speak, and speak strongly, without having previously acquainted itself with the facts. Our contemporary, in its issue of December 24th, said :—

"We print in another column a letter from a well-known firm of electrical engineers calculated to surprise the uninitiated as regards the manner in which certain incandescent lamps were entered for competition in some recent tests conducted by the Franklin Institute of America. It appears that several firms of electrical engineers, including the Swan, Maxim, and Woodhouse and Rawson, had refused to enter lamps for these tests, having no doubt satisfactory reasons for taking that course; but it would appear that a number of lamps, stated to be of the latter named firm's make, were entered without their knowledge or consent, half the so-called Woodhouse and Rawson lamps being supplied by the Edison Company, and the remainder from another electric lighting firm. We need not comment upon conduct so grossly unfair, or be surprised that the results of the tests should not be received by any firm of engineers as reliable. This conduct has been condemned, and rightly so, by the various electrical journals, and so the wrong done will to a great extent have been minimised. It is highly desirable that any tests of whatsoever nature which are sanctioned by the high authority of the Franklin Institute should be conducted with the most rigid fairness and impartiality, otherwise great harm is likely to be done to the injured parties."

Now, the manner in which the Woodhouse and Rawson lamps were obtained, together with the fullest particulars of the test and every detail connected with the matter, is faithfully recorded in the report of the Institute, and we would refer our contemporary to our leading columns of December 19th for further information regarding Messrs. Woodhouse and Rawson's ill-advised protest. In our opinion, there is no room for objection to the carrying out of the tests, everything in connection with which was fair, square, and above-board. How could it matter to the Franklin Institute what names certain lamps bore, so long as they were properly entered for tests by the competing companies?

MACHINES FOR THE ELECTRIC TRANSMISSION OF POWER.

THE machines which are at present effecting the electric transmission of work between Creil and Paris, states M. Marcel Deprez to the French Academy of Sciences, are not those which had been at first designed and constructed for that purpose. They have undergone considerable modifications, for reasons about to be given.

When I undertook the construction of dynamos of great power and high tension, several points remained doubtful. It might be asked :

1. If the laws of electric induction would remain without perturbation on changing the proportions and the arrangement of the magnetic field ?

2. If the loss of work caused by self-induction, the action of which had been recognised in machines of low tension, would not be intensified in machines of high tensions having great lengths of wire ?

3. If the loss of work resulting from the displacement of the magnetism in the soft iron of the induced rings would not increase with the mass of iron of these rings ?

4. If the sparks produced at the brushes in the working of the ordinary machines, would not assume a dangerous importance in machines of high tension ?

5. If it would be possible to insulate sufficiently the various parts of the system so as to prevent the electricity at a high tension from escaping ?

The answers to these various questions might be obtained by the study of existing machines, and a very justifiable extrapolation would give every satisfaction. Still the certainty could be complete only after the construction and trial of the machines themselves. These, also, had to fulfil special conditions. They had to be industrial, that is, substantial, easy to remove and to repair. They were designed and constructed to answer these ends.

When tried at the beginning of this year, it was at once perceived that they had a defect in their construction, the consequences of which might be dangerous. The iron core of the ring was composed of plates of soft iron, which ought to have been carefully insulated from each other ; they were not insulated, or at least very badly. Hence the machines, when at work, produced in this ring interior currents of the kind of those known as "Foucault's currents," which absorbed an enormous amount of work.

As may be supposed, the time of the stoppage and the serious delay involved in this error, caused some trouble to those concerned in the experiments. I must here express my gratitude to M. A. Sartiaux. engineer, sub-superintendent of the working of the Northern of France railway. From the first, he saw that the defect, in spite of the gravity of its consequences, had only an apparent importance, and did not affect the principles of the project. His firm and enlightened support was a valuable assistance in the continuation of the operations and in their happy conclusion.

It was necessary to re-make those parts entirely ; moreover, the magnitude of the defect was such that all study of the operations became impossible, and that none of the doubtful points could be thoroughly elucidated. Finally, time was pressing, as a limit had been fixed for the experiments.

Under these conditions, I resolved to place myself in the surest conditions. Renouncing industrial arrangements, and sacrificing for the time being, mobility, substantialness, and, even to some extent, the convenience of insulation, I endeavoured to fulfil the electric conditions only, eliminating, as far as possible, every cause of mischance, and adopting the most customary and best known arrangements.

The induced rings, studied from this point of view, were constructed ; they are now at work between Creil and Paris.

During this construction, by way of experiment, one of the old rings was repaired ; the plates composing the core were separated and carefully insulated. This tedious and delicate operation was successfully carried out by the care of M. E. Sartiaux, the head of the telegraphic service of the Northern of France railway. The ring thus re-made, was put to the trial, and it was found that it gave all the results which had been expected. When studied first with a few coils of wire folded diametrically, then with a certain number of sections, and finally completely coiled, it always gave the electromotive forces which had been expected. Further, it permitted an answer to the questions pending, and we know

1. That the laws of induction suffer no perturbation, whatever may be the magnitude of the machines and the dimensions of their magnetic field.

2. That self-induction has no more importance in large machines, with many folds of wire, than in small machines with a less number. This truth, indeed, had been placed almost beyond doubt by the study of machines of the ordinary Gramme type, which I had compared with my first high-tension machines ; this study had shown that machines having sections formed by 4 metres of thick wire, and others having sections formed of 75 metres of fine wire, had exactly the same coefficient of loss.

3. That the work produced by the movement of the magnetism in the iron remained in all machines, approximately capable of being neglected.

4. That sparks at the brushes may always be avoided by establishing a due relation between the power of the magnetic field, the current developed, and the position of the brushes. It was further recognised that from this point of view machines of high tension were, in fine, more favourable than others, by reason of the relative weakness of the currents developed.

When these tests had been made, it would doubtless have been preferable to recur to the original rings, suitably repaired. But time pressed, the new rings were just completed ; they answered the demands of the experiment, and I had to make use of them.

It will be remarked that there has been no mention of insulation : this difficulty is not of a theoretical nature, and it was certain that it might be overcome by a proper practical study. The present machines, though not possessing all the arrangements which I had prepared to that end, have already arrived at a high point of perfection ; they bear very high electromotive forces, and very violent electric shocks.

As for the conductive line, its general insulation is very good, as well as the mutual insulation of its two component wires going and returning. It was impossible to find here an appreciable electric loss in spite of the extremely bad weather which we had to encounter. It may from the present be considered as certain that an aërial line, upon posts, carefully constructed, will be an excellent conductor for the electric transmission of power. Still, under the present condition of things, it remains exposed to one class of accidents when traversing towns. That the wire of the line may pass near conductors serving for telegraphy or other purposes, cannot be avoided. There may hence occur, among these conductors, temporary or continued contacts. By a regrettable chance, an accident of this kind took place the very day when a number of the members of the Institute kindly visited the Creil-Paris experiments—an honour for which I profoundly thank the Academy.

The consequences of these accidents are less serious than might be expected, considering the sparks which they produce. Well-constructed machines resist their action, and the machines, Creil-Paris, resumed their action immediately after the stoppage occasioned by a contact of this kind.

Still, such interruptions in the working of the machines will be easily avoided. They must retain the regular, satisfactory movement which MM. the Members of the Institute have been able to observe on this occasion. This result will be reached by practical study. Experience will show which of the conceivable arrangements must be adopted.

It is, therefore, permissible for me to say that all the points which might give rise to doubt as regards the electric transmission of great powers to great distances are now elucidated. If the machines now at work have not all the industrial qualities which might be wished, circumstances are the sole cause. The former models constructed possessed them, and nothing opposes their being given to the definitive types.

THE CREIL EXPERIMENTS.

WE briefly stated in the REVIEW for last week that the experiments on the electrical transmission of power conducted by M. Deprez before members of the French Academy were not very promising. A partial explanation of the causes which occasioned the failure was also given, but, as it would doubtless be of greater interest to our readers to learn all that has yet transpired in connection therewith, we now publish the report presented by M. Sartiaux to the Academy, and which he entitles

An examination of the causes which have temporarily interfered with the experiments on the transmission of power between Creil and Paris.

I have caused the line for the transmission of power between Creil and La Chapelle to be examined in detail with a view to discovering the causes to which must be ascribed the incident which temporarily interfered with the experiments of transmission during the visit of the members of the Academy of Sciences to Creil.

The following is the summary of the observations made :

The telegraphic wire which serves for correspondence between the two sheds of the electric machines at Creil and at La Chapelle was brought into momentary communication, by the wind with the bare experimental line, by means of a tree which the heavy rain of the entire day had rendered a sufficiently good conductor. The current coming from Creil had been, in part, conducted away by the iron wire of this telegraphic communication, and had produced the spark observed at La Chapelle and at Creil, which burnt certain small pieces of apparatus.

A complete contact has been discovered between the wire of the artillery bureau of St. Denis and the upper wire coated with lead, serving for the transmission of force, which the former wire traverses near Fort La Briche. A discharge, it appears, had been produced at the bureau of the artillery.

The wire of Fort La Briche, which has been only recently laid down, had been placed at an insufficient distance from the conductors serving to transmit force. Finally, there was found, at a pole near St. Denis, an insulator broken and burnt at a point where the lead was destroyed and where the tarred tape, serving as an insulator, was burnt. What was the cause and what the effect it is not easy to decide. What is certain is that during the experiment sparks were seen at this post.

All the repairs are now completed and the line has recovered the perfect insulation of the first days. I have again had all the points of attachment of the cable inspected at each insulator.

In fine, the accident which occurred for the first time during more than a month is due to a defect in the insulation of the line of transmission, resulting from accidental communications with the earth, easy to be avoided. It appears to me that precautions should not be made light of and that an uncovered wire placed out of the reach of the hands, and at a sufficient distance from any adjacent telegraph wires is often preferable to a wire perfectly insulated as is ours during a great part of its length.

ON THE TRANSITION RESISTANCE IN THE ELECTRIC ARC.

IF the apparent resistance of the arc is measured in the ordinary manner, writes E. Edlund, in *Annalen der Physik und Chemie*, we find that it consists, so to speak, of two parts, one of which is independent of the length of the arc, whilst the other is proportional to it. If the resistance is designated as w, the length of the arc as l and two constants as a and b, then $w = a + b\,l$. This holds good if the strength of the current is kept constant whilst the length of the arc varies. The behaviour of the constants, a and b, differs in so far that b decreases when the strength of the current increases, whilst a is almost independent of the strength of the current and of the electromotive force of its source. Only, however, if these are so far reduced that an arc is scarcely produced at all, the value of a becomes somewhat smaller. These, my observations, have been confirmed by the most recent investigations.

The question may now be raised whether this constant, a, represents a transition resistance which occurs at the surface of contact between the electrodes and the air, or whether it has its origin in an electromotive force. The diminution of the strength of the current occasioned by a can be explained by either of these hypotheses. From reasons given in the author's earlier memoirs it follows that a represents an electromotive force which acts against the main current in an opposite direction.

Among the researches which have been recently undertaken on this subject, we will call attention only to the following :—

Fröhlich, who used in his researches the observations made in the laboratory of Siemens and Halske, came to the conclusion that both of the above hypotheses could be in harmony with these observations, but he seems to prefer the view that the constant, a, represents partly an electromotive force and partly a transition resistance. That a does not exclusively represent an electromotive force he thinks probable because, in that case, the force required would reach the value—in his opinion improbable—of 39 volts. Peukert has also made a number of observations on this subject, in which the strength of the current varied between 10 and 30 ampères. As it appears from my earlier researches, Peukert found that the apparent resistance of the arc might be expressed by the formula $w = a + b\,l$. If we assume that the constant, a, is an electromotive force, its value, according to Peukert, must amount to 35 volts. This value seemed to him so high, that he did not venture to assume that it could have its origin exclusively in an electromotive force, but must represent in part a transition resistance.

From my above cited observations it follows that a depends neither on the strength of the current nor on the power of its source, except the current is reduced to the lowest limit at which an arc can be produced. In my first experiments I calculated a as an electromotive force expressed in Bunsen elements. Seven successive experiments, performed with batteries of from 55 to 79 Bunsen elements, gave the following results :—

a = 24·616 ; 25·962 ; 25·354 ; 20·951 ; 21·637 ; 21·483 ; 23·119 ; giving as mean = 23·315.

This holds good if the arc is produced between carbon points of the kind usually employed for this purpose.

If we assume that 1 Bunsen element = 1·7 Daniell, and that the latter = 1·08 volt, then 1 Bunsen = 1·8 volt. If this last number is multiplied into the mean above given, we obtain 41·97 volt. The mean of this number and those found by Frölich and Peukert (39 and 35) gives 38·66 volt.

The view entertained by some investigators that the constant, a, represents in part a resistance of transition is in fact refuted by the research of Victor von Lang. By an ingenious method he succeeded in proving that the luminous arc contains a counter-electromotive force of 39 volts. As this value of the counter action in the arc is almost equal to the value of the constant a as given above, it follows that a so-called transition resistance in the arc does not exist, and that consequently the entire decrease of the strength of the current which arises by the introduction of the arc is occasioned by the resistance of the arc (b, l) and by the counter-electromotive force therein contained.

Here, however, it must be noted that as the determination of the values of a and of the counter-electromotive force were possibly made with carbon electrodes of different kinds, it would be desirable to repeat both determinations with one and the same arc.

THE COMPETITIVE TESTS OF THE EDISON AND WESTON DYNAMO-ELECTRIC MACHINES.

AN advance proof of the following communication by Mr. C. F. Heinrichs to the New York *Electrical World* has been forwarded to us by Mr. Heinrichs for publication :—

Having carefully gone over the report of the special committee of the Franklin Institute and their tables of tests, and compared the same with other tests on record, I note that the data of the horse-power absorbed by the friction of the armature varies considerably from the results obtained by other authorities. I regret that several data required to check more fully the results published are not given ; thus the weights of the armatures and the pressure of the brushes upon the commutators are omitted, from which, with the number of revolutions, one could well calculate the H.P. absorbed by the friction of the armature, which, if found correct, would credit the value of the total H.P. as given.

There can be no doubt that armatures of the same makers, having approximately the same weight and number of revolutions, will absorb approximately the same H.P. in friction when running without load ; thus, when comparing similar tests with each other, they ought to show similar results. The items of armature friction and total H.P. absorbed, if taken too small, will show an enhanced efficiency of the dynamo, and discredit the total H.P. measured.

Careful tests have been made in London, in 1882, during the International Electrical Exhibition, by the appointed committee, having Prof. W. Grylls Adams, F.R.S., as chairman. The particulars and tables of tests were given by Prof. Adams in his inaugural address before the Society of Telegraph Engineers and Electricians, on January 10th, 1884. I shall refer to these tests, and also to the exhaustive tests of my own dynamo, made by Messrs. Alabaster, Gatehouse & Co., in London, March, 1884. The particulars of these tests were given in *Engineering*, and are also contained in Dredge's " Electric Illumination," Vol. II.

I have extracted from the above-named tests several data, and arranged the same with corresponding data from the Franklin Institute Committee report in the two following tables :—

TABLE A.

	Edison Dynamos.			Weston Dynamos.		
	Franklin Committee.		Prof. Adams's tables of tests.	Franklin committee. Table III., test 1.	Prof. Adams's table of tests.	Heinrich's Dynamo. A. G. & Co. Tables, test 5.
	Table VI., test 5.	Table II., test 1.				
Electrical energy in horse-power	68·25	35·67	12·52	28·47	10·65	7·53
Probable weight of armatures in pounds	800	500	200	400	200	50
Number of revolutions of armature	1092	1208	1096	1043	...	1680
Horse-power absorbed by friction of armature	·393	·437	1·565	·3115	1·337	·51

This table contains the extracted data of six tests made of six different machines by the authorities named. The quoted electrical energy in H.P. serves to indicate the size of the machines, and from the (probable) weight of the armatures, with the number of revolutions, one can roughly form an estimate of the H.P. absorbed by the friction of the armature. The other extracted figures show that the H.P. absorbed by the armature friction of the Edison and Weston machines, tested by the Franklin committee, amounts only to a fraction of a H.P., while the H.P. absorbed by the armature friction of machine of the same makers, but measured by Prof. Adams, is from four to five times larger, notwithstanding the latter machines are only one-fifth to one-third the capacity of the former.

Observing these facts, one cannot help asking : Which are the true or most probable figures ? In answer I will point out the fact that in Prof. Adams's tests, all H.P. measurements were checked with an absorption dynamometer. Practice has shown that under varying conditions all transmission dynamometers are unreliable, and no calculations ought to be made from their indications, but the indications should be observed and afterwards reproduced by applying an absorption dynamometer, from which the power absorbed can be got very exactly in foot pounds. Further, during the exhaustive tests of my dynamo it appeared that the armature, weighing 50 pounds, with 1,680 revolutions, absorbed ·51 H.P. Now, the Franklin Institute Committee has actually measured less power as being absorbed by an Edison armature (Table VI., test 5), weighing probably 16 times as much as my armature. (See machines 1 and 6 in Table A.)

All other measurements made by Prof. Adams of the other armatures, viz., the Brush, Gramme, Burgin, &c., agree well and are proportionate, which cannot be said of the Franklin Institute Committee measurements. In fact, the H.P. absorbed by the friction of an Edison armature giving out an electrical energy of 68 H.P. has been put down as ·393 H.P., while the H.P. absorbed by the friction of another Edison armature, of half the capacity, has been given as ·437 H.P. (See machines 1 and 2 of Table A.)

TABLE B.

EDISON DYNAMOS.

Tested by whom.	Electrical energy in H.P.	Total H.P. absorbed by dynamo.	H.P. absorbed by friction of armature.	Electrical efficiency.	Commercial efficiency.
Franklin Committee Table V., test 1 ...	12·51	13·284	·14	94·21	88·42
Prof. Adams's tables of test	12·52	15·27	1·565	91	74*
WESTON DYNAMOS.					
Franklin Committee Table IV., test 7	10·40	10·774	·167	96·53	90·10
Prof. Adams's tables of test	10·65	13·83	1·337	85	61*

* Calculated by the writer.

I have arranged, in Table B, extracts from tests of an Edison and a Weston dynamo, made by the Franklin Institute Committee, with tests of another Edison and Weston dynamo, but made by Prof. Adams. The dynamos of each maker are of the same capacity, and give almost the same electrical energy in H.P. during the tests. Thus the two results of each set of tests ought to correspond approximately with each other, but, as seen, the figures given by Prof. Adams of the H.P. absorbed by the armature friction is 11 times larger than the Franklin Institute Committee's results. Also the total H.P. absorbed is given considerably larger by Prof. Adams ; consequently the efficiency of the Edison and Weston dynamos is considerably lower than that given by the Franklin Institute Committee.

These serious differences in the results obtained by such eminent authorities led me to make calculations of the probable H.P. absorbed by the friction of the armature of the six machines of Table A. To do this I required to know the weight of the armatures, the pressure of the brushes upon the commutators, which are not given in the report. I had thus to find these data, and I got them on comparing my machine with the others. The weight of my armature is 50 pounds,

which is one-tenth the total weight of the machine. I use the least copper (only 16½ pounds for an electrical energy of 7·53 H.P.); thus the probable weights of the other armatures, as given by me, are most likely smaller than in practice. Further, the pressure with which both of my brushes are held to the commutator I found to amount to 7 pounds for a current of 23 ampères; thus the probable brush pressure I accepted for the other and larger machines, giving a larger current up to 400 ampères, will also be found to be less than actually used.

The results of my calculations are given in Table C.

TABLE C.

	Edison Dynamos.			Weston Dynamos.		
	Franklin Institute Committee.		Prof. Adams's tables of tests.	Franklin committee. Table III., test 1.	Prof. Adams's tables of tests.	Heinrich's Dynamos. A., G. & Co. Tables, test 5.
	Table VI., test 5.	Table II., test 1.				
Diameter of bearings in inches	2⅜	2⅜	1¼	1¾	1½	1¼
Probable diameter of commutator in inches	5	4	4	4	4	3
Probable pressure of brushes upon commutator in pounds	12	10	8	10	8	7
H.P. absorbed by friction of bearings	·98	·67	·14	·3199	·14	·038
H.P. absorbed by friction of brushes	·559	·38	·27	·3347	·275	·283
Total H.P. absorbed by friction of arm ...	1·530	·99	·41	·6546	·415	·32

I used the following formulæ:

1. H.-P. absorbed by friction of bearing in journals:

$$\frac{\mu\, w\, (\pi\, d)\, n}{33{,}000} = \text{H.P.}$$

μ, coefficient of friction = ·054;
w, weight of armature in pounds;
d, diameter of bearings in feet;
n, number of revolutions per minute.

2. H.P. absorbed by friction of brushes upon commutator:

$$\frac{\pi\, d\, w\, n}{33{,}000} = \text{H.P.}$$

d, diameter of commutator in feet;
w, pressure of brushes upon commutator in pounds;
n, number of revolutions per minute.

Comparing the calculated results with the measured results of Table A, it becomes evident that the H.P. absorbed by the friction of the armature, measured by the Franklin Institute Committee, is given too low, while Professor Adams's results are larger than the calculated. The latter fact can well be explained, viz., that the data upon which I found my calculations are taken too small; on the other hand, my calculations would only show what results could be obtained, under the most favourable conditions of the frictional surfaces, such as in practice we do not always have. New machines will have greater friction, and the coefficient becomes much larger.

Further, in my calculations no account has been taken of the resistance of the air, which is considerable if the armature is slightly uneven, and in fact the armatures are always more or less uneven; all these considerations explain well the differences between the calculated and the measured results of Prof. Adams. The actual H.P. absorbed by armature friction may be larger than the calculated; *but it cannot well be smaller* than the amount appearing from the figures of the Franklin Institute Committee.

The results obtained by Messrs. Alabaster, Gatehouse and Co. of the armature friction of my dynamo are also larger than my calculations show, which proves that the correctly measured H.P. would be more reliable than the calculated, while the calculated H.P. will serve as a check against errors and too small values being accepted.

The horse-power tests of the Franklin Institute Committee are altogether in the other direction. Thus the tests of the large Edison machine (see Table A) show the total armature friction to be ·393 horse-power, while my calculations in Table C show the mere friction of the bearings to amount to nearly three times that amount.

These differences cannot well be explained, particularly when comparing the weight of that large Edison armature with the weight of my small armature, which absorbs ·51 horse-power. Adding the other unproportionate figures given in this item, further, the great differences between the committee results and the more probable results of Professor Adams, one cannot help rejecting all horse-power measurements made by the committee, and the efficiency of the Edison and Weston dynamos stands unsupported. The only figures on record are those of Professor Adams.

	Efficiency.	
	Electrical.	Commercial. *
Edison	·91	74
Weston	·85	61

* Calculated by the writer.

In the tests of my dynamo the H.P. absorbed *for producing the electrical energy* was calculated from Prony brake readings (see description of tests), which were taken under conditions excluding any doubt as to the results obtained being correct. The H.P. absorbed by the armature friction agrees well with Professor Adams's tests and all the before stated facts. Thus the high efficiency given to my dynamo stands well supported by the tests which have proved it to have the highest efficiency on record, viz.: Electrical efficiency, 98 per cent.; commercial efficiency, 76 per cent.

If the dynamo be constructed as a shunt wound machine, it will give a still higher commercial efficiency.

CHARLES F. HEINRICHS.

New York, *Dec. 11th*, 1885.

THE ELECTRIC LIGHT IN PRIVATE HOUSES.

THE following communication by Mr. Charles J. Phipps, F.S.A., has been handed to us for publication:—

Having now tried for 12 months the experiment of entirely lighting my residence and offices with the electric light, the result of my experience may be of some general interest. The installation here was carried out by the Electrical Power Storage Company with 27 of their patent accumulators (31 L type), 24 of which are in constant use, with three in reserve. The power is obtained from an Otto gas engine, erected by Waygood, of 1 horse-power nominal, indicating nearly 2 horse-power, and an Edison dynamo of 90 volts 16 ampères. The house, including bed rooms, is lighted by 50 Swan incandescent lamps of 50 volts and 20 candle-power each, burning a current of 1·3 ampères per hour.

On the 31st of October the installation had been working 12 months most successfully; in fact, during this period we have never been without the light for a single night. There have been one or two slight breakdowns with the engine and dynamo, necessitating the stoppage of work for one or two days, but on each occasion the amount of electricity stored in the accumulators has been sufficient to keep the house well lighted for nearly a week. The accumulators after their 12 months' work do not evince any signs of deterioration, and I am informed that they should last for some years yet, and, when necessary to replace the plates, it

can be done at a small cost. The Edison dynamo gives a current varying from 12 to 15 ampères, which, from such a small power engine, is very satisfactory. The armature makes from 1,260 to 1,320 revolutions per minute, and there is not the slightest heating in any part of the machine. The 50 lamps throughout the house are all turned on and off by separate switches, with the exception of the cluster lights, or "electroliers," in the principal rooms, which have one switch for each cluster of five or six lights. In each bed room are two lamps in the usual position by the dressing tables, one of which can be turned on just inside the door, and the other by the bedside, and this mode of arranging the switches at the entrance to each room has been generally adopted ; attached to each switch is a safety fuse. The dining room having an enriched plaster ceiling, the question of carrying the wires was one of some difficulty, but it was so managed by careful manipulation that the most critical observer would fail to detect the mode in which they are carried round delicate mouldings from the wall to the centre of the ceiling.

The engine has worked on an average for the year 4½ hours a day, at a cost per diem of a fraction under 6d. The total cost of the installation, exclusive of fittings, was about £300. The engine and dynamo has been looked after by an electrician, who comes generally every other day, but the daily working of the machinery for the first nine months has been under the superintendence of my son, since which time one of the gentlemen in my office has taken it in charge. The working expenses have been as follows :—Payment to electrician, £12 12s. 6d. ; gas for engine, £8 15s. 2d. ; repairs to engine, £1 19s. ; oil for engine, £2 4s. 1d. ; repairs to dynamo, 7s. 9d. ; brushes for dynamo, 13s. 9d. ; attachments, 9s. ; breakage of 15 lamps, at 5s., £3 15s. ; waste, laces for belt, and sundries, 8s. 9d. ; total, £31 5s.

I have also kept a register showing how many ampères have been burnt nightly by each lamp, and by that means can tell to an hour the life of every lamp that has broken. The machinery is in a room about 11 ft. by 10 ft., on the basement, and immediately under the room in which I pass most of my time, and there is not the slightest vibration or noise. I am quite convinced that for absolute steadiness of light the working by means of accumulators is the best plan, and whenever the lighting by electricity takes a more extended form, and "centres" for producing it are established, accumulators, it appears to me, will then be advantageous to prevent the pulsation of the lights, and to provide against a possible break down of machinery at the "centres." At the end of the 12 months' trial I am quite satisfied with the result of my experiment : the rooms are never overheated from the fumes of gas, and the ceilings and wall decorations are as clean and free from deterioration as when first put up.

THE PROFITABLE SECTION OF AN ELECTRICAL CONDUCTOR FOR THE TRANSMISSION OF POWER.

THE question was recently put to me, says Mr. Thomas Whiteside Rae, C.E., in the New York *Electrical World*, whether or not the cross-sectional area of a copper conductor intended to convey a current of some magnitude a moderate distance for power purposes was needlessly large, and I found the investigation so interesting, and involving so many generally unsurmised factors, that it seemed to me a worthy subject for a monograph.

The amount of power to be circulated in the form of current was 500 horse-power, the length of the circuit 4,000 yards, or 2·27 miles, and the cross-section of the copper conductor 3·25 square inches. The potential of the current was restricted to 120 volts.

The current equivalent of 500 horse-power being 373,000 volt-ampères, it followed that the theoretical value of the current flowing in the circuit would be 3,108 ampères.

This, however, is subject to correction for the loss involved in the conversion of mechanical work into current ; which is due to the frictional and electrical resistances of the generating dynamo, and whose minimum—so far as known—is about 13 per cent. It will be prudent and more in accord with other conditions of the problem—to be stated later—to put this loss at 15 per cent., and consequently there may be considered to be a current of 2,642 ampères flowing in the conductor.

It is evident that the flow of any appreciable current in any practicable conductor must evolve heat. If a uniform temperature of conductor is to be maintained, this development of heat must be got rid of by radiation or conduction ; or it becomes cumulative and detrimental, by creating a wasteful resistance in the circuit and, in the case of insulated conductors, sometimes destroying the insulating medium.

The latter class of conductor would seem to offer especial difficulties, and the problem is as yet too new to have invited much investigation or experiment. While it is undoubtedly true that the best dielectrics are, probably without exception, the worst conductors of heat, and the rates of their efficiency, in this sense, practically unknown, it has also been experimentally demonstrated that insulated conductors have even less tendency to augment temperature under the passage of a current than bare wires. This is a deduction from laboratory tests, and must be accepted only within proper limits. The seeming paradox vanishes when one reflects that the worst possible conductor of heat is dry motionless air, and that the larger periphery of the insulated wire radiates the greater quantity of heat in the same time. The result would be reversed if the two types of conductor were exposed to draughts of wind ; but the instance is cited to show that the general formulæ are applicable to both classes. Without being willing to rest for an instant under the imputation of reflecting upon the utility — nay, the indispensableness—of sound generalisation, I cannot refrain from calling attention to the prominent part taken by judgment in every problem in physics. Every case may be said to be a special case, and in view of the numberless and unforeseeable influences affecting the temperature of a subterranean conductor two-and-a-quarter miles long, it seems almost finical to be calculating the effect of a few degrees due to current resistance. Nevertheless, the investigation is of importance.

It is presumable that a conductor buried in homogeneous earth and well below the frost line would retain about a uniform temperature all the year round, but that temperature would depend upon the nature of the soil.

It would naturally be one thing for clay, another for sand, and another for rock ; and none of these could be known except by experiment. In all probability, a conductor of any considerable length would pass through all varieties of soil, across places alternately dry and wet, possibly near steam pipes, and any attempt to assign quantitative temperature to them would be farcical. In such circumstances, the only recourse is to general formulæ, as furnishing — all things considered—as fair an average of the conflicting influences as possible, and one of Clark and Sabine will do as well as any. It is

$$\theta = 0{\cdot}2405 \, \mathrm{R} \, \mathrm{C}^2 \, t,$$

in which

θ = units of heat.
R = resistance in ohms.
C = current in ampères.
t = time of flow in seconds.

Since the current in this case is practically continuous, t will disappear, and the factor, R, must be deduced, Clark and Sabine again furnishing the means with their formula

$$\mathrm{R} = \frac{1002{\cdot}4}{w},$$

w being the weight in pounds of a statute mile of the conductor whose resistance is sought.

In the case in question the weight of a statute mile is 65,261 lbs., and its resistance at 60° Fahr. consequently ·01536 ohm; making the resistance of the entire 4,000 yards ·035 ohm.

Carrying out the operations indicated by the formula, it will be found that

$$\theta = 58756;$$

that is to say, the given current will develop in the given conductor so many units of heat.

If it were conceivable that the substance of the conductor was water and weighed just 58,756 pounds, this would mean that its temperature would be raised one degree Fahrenheit. But its material is copper, whose specific heat is ·092 or—familiarly speaking—which requires but ·092 of the quantity of heat that water does to affect its temperature equally; and its weight, as has been seen, is 148,320 pounds.

Adapting the result to these conditions, it will appear that the conductor under consideration will have its temperature raised by the current circulating in it, only 4·17° Fahrenheit, above what it would be if out of circuit.

This increment is so trivial with regard to any harmful influence it might exert upon the insulating medium used with the conductor, that search must be made in other directions for the reason which prescribes its seemingly excessive size.

Good gutta percha will endure a temperature of 120° Fahr. before failing, and India rubber 300° Fahr. So the cause sought for is probably supposed to be the reduction of current, and consequently of merchantable horse-power, resulting from an increase of resistance by augmented temperature.

The resistance of copper increases $\frac{21}{100}$ of one per cent. for each additional Fahrenheit degree of temperature, and in the case of the predicated current and conductor, the resistance of the latter will be enhanced but $\frac{86}{100}$ of one per cent. For the purposes of discussion, the loss of current due to this augmented resistance will be ignored for the present. To estimate the effect of such increase of resistance from a financial standpoint, the subjoined method is convenient.

The 2,642 ampères of current flowing in the conductor are subject to a farther diminution, before they appear in merchantable shape, which occurs in their transformation by the converting dynamos into horse-power.

It may be safely taken at 17 per cent.; which amounts to the admission that, of the 500 horse-power applied to the generating dynamos, but 70 per cent. may be counted upon returnable, in the same form, from the converting dynamos. One of the postulates of the problem was that at least this proportion of the applied mechanical power should be recovered after having undergone all its transformations, and the loss has been equally divided—which is probably as fair an allotment as possible—between the two conversions.

There should be, then, 350 horse-power available for the production of revenue; but, owing to an idiosyncracy of electric power there is very much more. An instant's reflection will satisfy one that where an amount of power is distributed among a number of consumers for intermittent use the chance of every one's desiring to avail of his power at the same instant is infinitesimal, and experience, as far as it goes, confirms this. The character of the work done may also originate compensating influences to the same end, as when the power circuit includes elevators which not only consume no power in their descent but even reinforce the main current with the counter currents created by their own dynamos revolving under stress of their downward gravitation. It would be difficult to make too much of this characteristic, to which is largely due the wonderful economy inherent in this system of power distribution, and which is so prominent in the case of electric railways as to elicit the statement from the late Sir William Siemens that two trains on the same pair of rails, one ascending and the other descending a grade, influenced each other through the common current as absolutely as if connected by an actual rope.

It is this instantaneous adjustment throughout the entire circuit of the supply of, to the demand for, power that precludes waste or superfluity of it.

It is, therefore, considered perfectly prudent with an ordinary power plant to contract to deliver about double the total capacity of the generator.

In the problem under discussion, the quantity of marketable power was limited to 500 horse-power, which represents an annual rental of $60,000.

It thus appears that every one of the 2,642 ampères of current flowing in the conductor has a market value of $22.71 per annum.

On the other hand, the specified conductor—at the present depressed price of copper, say 15 cents per pound—would cost $22,248; the annual interest on which, at 6 per cent., would create an annual debit of $1,335.

Ohm's fundamental law of currents furnishes a useful point of reference at this juncture, viz.:

$$C = \frac{E}{R}$$

in which C = current in ampères,
R = resistance in ohms,
E = electromotive force, or potential, in volts.

As the latter factor is fixed at 120 volts, unity may be substituted for it in the formula, viz.:

$$C = \frac{1}{R}$$

which then signifies that the current varies as the reciprocal of—or inversely as the resistance. Colloquially, it reads: having the same electromotive force, to double the current, halve the resistance, and *vice versa*.

In conductors of similar material and equal length, the relative resistances would be inversely proportional to their cross sections—*or to their weights*—and the final deduction is that currents of uniform potential moving in conductors of the same material and of equal length vary as the weight of the conductors.

A convenient unit of comparison is the annual market value of the ampère which, as has been shown, is $22.71. As the number of saleable ampères in the case in point is a function of the weight of the conductor, the annual interest upon which *per pound* is $.009, viz.:

$$\frac{\$1,335}{148,320} = .009$$

it follows that it would require the annual interest upon 2,301 pounds of copper, viz.:

$$\frac{\$22.71}{.009} = 2,523$$

to equal the annual value of one ampère.

Supposing the conductor to be reduced in weight by this amount and applying the rule deduced for this especial case—of the current varying as the weight—it appears that such a reduction would diminish the current some 108 ampères, viz.:

$$\begin{array}{r} 148,320 \\ 2,523 \\ \hline 145,797 \end{array}$$

$$148,320 : 145,797 :: 2,642 : 2,597$$

$$2,642 - 2,597 = 45$$

whose annual value is $1,022.

It thus becomes evident that the diminution of weight would entail vastly greater loss of revenue than the annual saving achieved thereby. Reducing the two opposing quantities to a common unit will give useful constants for the case under discussion, viz.:—

Annual interest at 6 per cent. on 1 lb. copper = $.009.
Annual revenue from 1 lb. copper = $.40
Weight of copper per ampère = 56 lbs.

From which it appears that until the price of copper rises 45 times above its present figure, or the value of

the ampère falls the same number of times below that assigned to it in the comparison, or a change occurs in both, producing a similar mutual relation, any reduction of weight in the conductor—all other factors remaining constant—would be a source of loss rather than of profit. Since it seems incontestably proven that for the stated case and specified conditions any diminution of the conductor would be prejudicial, it becomes of interest to know if the weight might be profitably increased.

It will be remembered to have been shown early in the discussion that the given current raised the temperature of the conductor 4·17° Fahr., which increased its resistance ·86 of one per cent.

Since current varies inversely as resistance, viz.,

$$100{\cdot}86 : 100 :: 2{,}642 : 2{,}619 + 2{,}642 - 2{,}619 = 23,$$

it appears that this trifling increment reduces the flow by 23 ampères, whose annual value is $522.33. In the given conductor and under the prescribed conditions, each ampère requires 56 lbs. of copper, and the addition of 1,288 lbs. ($56 \times 23 = 1{,}288$), the interest on whose cost is but $11.59, would make good this very considerable annual loss. Increasing the conductor by this amount of copper would enlarge its cross-section from 3·25 to 3·30 square inches—a barely appreciable area.

It is evident that the method employed is only approximative, and may be continued to any desired degree of precision. There is no pretence of close accuracy, and it is even less than it might easily be, on account of ignoring fractional quantities and the ordinary small errors in the deduced factors made use of. The idea has been to rather suggest a method of dealing with such questions than to furnish absolute results. It seems to show that the formula published by Clark and Sabine is sufficiently exact for any case in ordinary practice.

The reasoning is rational rather than analytical, and probably could not be expressed by a mathematical abstraction. At all events, I am not sufficiently facile in the processes or symbolism to attempt it myself, and commend it to the attention of such as are.

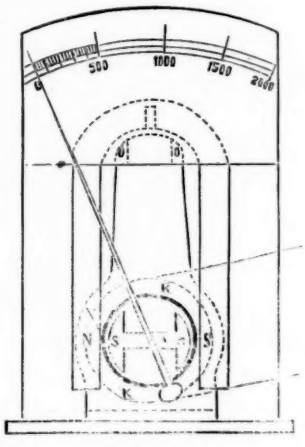
AN ELECTRIC SPEED INDICATOR.

THIS indicator is the invention of Dr. Th. Horn, of Leipsic, Germany, and the instrument is based upon the well-known Arago experiment of causing the needle to be deflected in the same direction in which a copper disc above it is rotated, the deflections being proportioned to the speed of rotation. Since each speed corresponds to a certain deflection, the principle can be applied in a speed indicator.

The instrument is shown in the accompanying illustration, the weak directive action of the earth's magnetism being replaced by more powerful permanent magnets, N, S. The needle is replaced by an I-shaped armature of soft iron, which is movable between the poles, N, S. Instead of employing a disc, a thick cylinder or sheath of copper, K, is placed around the armature, which latter is far more affected than if a disc were used. Within the limits of 40° to 45° the deflections are proportional to the speeds, and hence the apparatus is a practical speed indicator.

The question naturally arises as to the constancy of the deflection with a certain speed when the strength of the directing magnet, N, S, varies. If we assume that the magnet consists of two equal sheets or lamellæ, and imagine one of them to be removed, then not only will the strength of the poles, N, S, be reduced one-half, but those also of the armature, *n*, *s*, will be similarly affected, provided the latter was not magnetised to saturation. Since the attraction between the poles N, *s* and S, *n* is proportional to the product of their strengths, the torsional moment between the armature and directive magnets for a particular position will only be one-quarter of the original.

But it is easy to see that the deflecting power of the rotating sheath is also reduced to one-quarter of its original value, since with constant speed the currents generated are reduced one-half, corresponding to the strength of the poles, *n*, *s*, the amount of deflection being the product of both. The forces acting with diminished magnetism are in the same relative proportions



as originally; in other words, *the deflections of the armature* (and consequently of the pointer) *are independent of the strength of the magnets.*

This explanation, says Dr. Horn in the *Elektrotechn. Zeitsch.*, is fully borne out by actual experiment. During the course of the latter, an electro-magnet was employed, the strength of which varied proportionally from one to four, but with constant speed no perceptible change in the deflection was observed.

MAGNETISM.

By WILLOUGHBY SMITH.

IN my position as electrician to the Telegraph Construction and Maintenance Company, it has always afforded me much pleasure to know that each effort of mine to advance the knowledge of electrical science has been most favourably and kindly received by the members of my electrical staff. It has therefore been to me a work of love to compile this pamphlet on magnetism, which, I sincerely hope, may be the means of giving assistance to those who are already engaged in endeavouring to gain a knowledge of the subject, and also of exciting an interest in those who have as yet given no thought to it.

Let it be assumed as correct, it not being of the slightest importance for my present purpose whether it be so or not, that a Greek shepherd, Magnet by name, whilst tending his flock on Mount Ida, found that there were in parts of the earth around him peculiar hard substances, from which, if he placed his iron crook upon them, he had difficulty in detaching it. Neither is it, at this time, of material importance to know the date of this discovery; but it may be noted, in passing, that it must have been a very long time ago, as Homer, Pythagoras, Aristotle, and other celebrated men of their time mention it in their writings. It is even asserted that Thales, the most ancient philosopher of Greece, was acquainted with the attractive power for iron possessed by the substance called magnet, this name being given to it, I suppose, with the view of perpetuating the name of the discoverer of what must have seemed in those days a supernatural phenomenon.

It does not, however, appear that these ancient philosophers attempted to gain knowledge by experimental research, although they were such close observers of

nature and its workings. No doubt the discovery of so strange and wonderful a phenomenon was a subject for much learned discussion and disputation in their schools of science; but they had not realised the important fact that theory and experimental research should go together, for useless is the theory that cannot be supported by experience, and experience, without some theory of generalisation and arrangement, would be nothing but a confused mixture of facts. Had this been more fully recognised it is possible that the most important property of the magnet—its directive force—would not have remained so long undiscovered. For it is recorded that it was not until the thirteenth century that it became known, at any rate in Europe, that when a magnet was freely suspended it turned one and always the same part of its surface towards the north pole of the earth, or a point not far from it; the opposite part of its surface, of course, pointing south; these parts were then termed poles.

When this directive force was practically applied to navigation and similar purposes, the magnet became more generally known as the "loadstone," a word said to be derived from a Saxon term signifying a "guide."

The magnet or loadstone is an oxide of iron of a dark gray or dark brown colour, found in almost all parts of the world, generally in irregular pieces of a few inches in dimension, although pieces have been found weighing over one hundred pounds and capable of supporting by suspension pieces of iron of double their own weight. It doubtless was soon observed that the directive force of these stones was very capricious, owing to the extraordinary difference in various parts of the same stone; for, while one part would attract, another would repel the same substance. This difficulty was surmounted by the discovery that by placing a plate of iron on each end of the stone, all the power of the stone appeared to centre itself in those iron plates and to give strong and uniform directive power. After the application of the iron plates it must soon have been observed that they, more or less, retained the property of the stone after their detachment from it, and that the harder the iron the more lasting was the effect. When the knowledge was fully recognised that the directive and attractive power of the stone could be imparted, without loss to itself, to hard iron or steel and permanently retained thereby, magnetised bars, or needles as they are now called, superseded the loadstone for ships' compasses and other like purposes, and the term magnet was again more generally applied. At the present time the word "loadstone" is very seldom, if ever, used, unless in application to the stone itself.

I have in my possession a natural magnet or loadstone. It is a magnetic iron ore of a specific gravity of 4·9, and, according to Bloxam, this variety of ore contains about 72 per cent. of iron. Its weight is 17,730 grains, but its attractive power is very slight, owing to its possessing what may be termed so many points of action. The attractive power at many of these points is scarcely perceptible; the strongest point will only support 17 grains of iron. But it will sustain a plate of iron weighing 1531·25 grains, if the iron be of sufficient surface to cover the whole of the base; and if the iron be extended so as to cover the two ends also, its attractive power will be increased to 24,062·5 grains. Taking the soft iron end pieces separately, while in contact with the stone, their respective attractive power is—

North	...	...	...	2645 grains.
South	...	...	...	2437·5 „

If one of the soft iron pole pieces be applied to different parts of the stone, then, as far as it is possible to ascertain, where any considerable attraction takes place between the stone and the iron, very little free magnetism is shown by the latter; but, if no attraction exists between them, free magnetism is manifested at the end of the iron. I cannot tell when this stone was first used for experimental purposes, but, forming my opinion from the antiquated character of the engravings on the brass case in which it is mounted, I should say it was at least 300 years ago; and, if I correctly interpret the engraved figures, its strength has, since that time, decreased more than 50 per cent. Writers on the properties of this class of ore or stone have frequently expressed their astonishment at the way this power, which we call magnetism, exists naturally in them. Even Faraday has said that "the way in which it exists at all times in a stone like this is the most remarkable fact connected with magnetic force." Whenever giving thought to the subject I always imagine the earth as one huge loadstone, and consequently look upon it in the same way as upon the small stone, the properties of which I have just given; for if the world could be experimented with in precisely the same way, similar results would be obtained, the only difference being the high attractive and directive power of the one over the other, owing to the vast difference in their dimensions. This would be analogous to experiments carried out with a huge magnet and a very minute portion of the same, for similar magnetic effects would be obtained in each case, but the difference of the intensity between the two would be very great. Astronomers consider the world an oblate spheroid body, elevated at the equator and depressed at the ends, and, for convenience, they imagine a line passing through its centre, and the extremities of this imaginary line they term the poles. Now at, or near, the place of these imaginary poles the earth has its strongest attractive magnetic power; consequently, proceeding from these two points are strong magnetic curved lines of force, which, by their polarisation effects, cause the atmosphere surrounding the earth to be one whole magnetic field. To what height those curved lines extend it is impossible to say, for we can only positively assert that the boldest aeronaut has not yet ascended beyond their influence.

When experiments in magnetism are being made, it should be constantly borne in mind that the work is being done in an atmosphere of magnetism, the lines of force of which vary in intensity according to the position on the earth at which the experiments are made; and not only the position, but also the time and temperature. If this be really the state of the planet on which we dwell, may it not be probable that the other planets, which are said, like this world, to be "swimming" in the medium of space around the sun, each one being surrounded by its own atmosphere, are similarly affected; and that polarised magnetic lines of force are the means employed by the great Architect of the universe (who, as far as our limited knowledge extends, employs no rectilinear motions or angles, but all motions created by Him are performed in curved lines) to bind together and control the whole system.

Having discovered the attractive and directive power, and the dip of the magnet, it appears to have been assumed that the whole subject was exhausted, as very little more attention seems to have been given to it, until Dr. Gilbert, in the year 1600, published his original treatise on the magnet. This created quite a new and enthusiastic interest in the subject, especially his hypothesis of terrestrial magnetism, in which he assumed that the earth contained within itself a powerful magnet, lying in a position nearly coinciding with its axis of rotation. Some of the enthusiasts of the day accepted this hypothesis as correct, and looked upon it as one of the greatest discoveries in the annals of science; whilst others propounded new theories which as fully illustrated how erratic is the unbridled imagination, especially when it has overleaped the bounds of reason. Although the advancement of knowledge will not allow of the correctness of many things recorded by Gilbert and other writers of his time, yet it may be still admitted, with truth, that Dr. Gilbert did much to increase our knowledge, and that he is justly termed "the father of the science of magnetism." The magnetic effects which were observed to be produced by lightning: Franklin's discovery of the identity of lightning with electrical discharges

artificially produced: and the effects produced on magnetic needles by the aurora borealis, combined with the facts that similarly electrified bodies repel each other in the same way as those bodies which are similarly magnetic, and that dissimilarly electrified bodies will attract each other in the same way as those bodies which are dissimilarly magnetic, encouraged philosophers in their endeavour to identify the electrical and magnetic powers as one and the same. Powerful currents from large electrical machines, or from batteries formed of large Leyden jars, charged to their highest tension—the only known means in those days of generating and accumulating electricity—were passed through bars of steel or iron of all forms and under all conditions; but the results obtained were very slight and capricious, and showed no advantage over the magnetic effects usually produced by a blow given to a bar of iron from any mechanical action. Father Beccaria, a celebrated Italian philosopher, concludes his experiments in this direction by asking, "Are not these peculiar effects of this electric *fire* with respect to magnetism so many proofs which corroborate my former conjecture, that the peculiar magnetic force observed in *loadstones* is to be attributed to either atmospherical or subterranean strokes of lighting, and that the universal systematical properties of magnetic bodies are produced by an universal systematical circulation of the electrical element?" These remarks of Beccaria's do not appear to have attracted much attention at the time, but fifty years afterwards Ampère suggested a similar theory which attracted much attention, but then Ampère had had the advantage of two most remarkable and important discoveries which had been made since Beccaria propounded his theory.

It has often been found that experience produces facts which the wildest imagination never conceived even in its dreams. Bold, if not absurd, would have been considered the flight of imagination of the romancer who compiled his work from such incidents as those which belong to the history of Volta electricity. For instance, in 1790 an Italian lady slightly indisposed, was advised by her physician to partake of some frog broth; her husband, being an anatomist, at once proceeded to prepare the frogs, and, while so doing, observed that the disconnected limbs became convulsed with movements resembling vital action whenever they were touched at the same time with any two dissimilar metals, iron and copper for instance. The important results which have sprung from this simple incident illustrates the beautiful and unerring laws of nature developed under the most simple conditions, but which are too often, on that account, unheedingly passed by. This strange and startling phenomenon led to experimental research; and had Professor Galvani been more of an electrician, he probably would not have adhered so tenaciously to his theory of animal electricity. The results of Volta's experiments led him to assert that Galvani's theories were incorrect, and that the phenomenon was not due to animal electricity but simply to a current of electricity emanating from the surface of contact of two metals; but Professor Fabroni discarded both the preceding theories, and experimentally demonstrated that electricity was generated by the decomposition of the moisture lying between the two metals.

Each of these three hypotheses had their own partisans, but the controversy as to the origin of galvanic electricity, as it was then called, somewhat abated when, in March, 1800, Volta announced his discovery of the Voltaic Pile, composed of a combination of alternate discs of copper, zinc, and wet cloth. By this arrangement a generator of electricity was produced which gave a gentle and continuous current in large quantity, and not the sudden or instantaneous currents with uncontrollable and irresistible violence which had hitherto been obtained. From this discovery commenced the most splendid era in the history of electricity; it supplied experimentalists with a new implement for electrical research, amongst the former users of which was Sir Humphrey Davy, who, although a young man of only twenty-one years of age, not only put beyond doubt the fact that chemical action is essential to the vitality of the Voltaic pile, but showed different methods of generating currents, and thus localised, sufficiently for all practical purposes, the "seat of electromotive force in a Voltaic cell." A few years afterwards he published that most important discovery of the decomposition of fixed alkalies by currents of electricity generated by chemical action, and of the metallic nature of their bases, thus founding a new science of electro-chemistry. These discoveries burst so suddenly and unexpectedly upon the scientific world as to cause great wonder.

Electro-magnetism was again eagerly sought for, this time by the aid of the Voltaic pile, and, after twenty years of labour and thought, the experiments of Prof. Oersted carried him victorious to the desired goal; for he then discovered that an electric current, traversing a metallic wire joining the two poles of a Voltaic battery, will deflect an adjacent magnetic needle from its natural direction; and that, in the absence of interfering forces, the latter would be placed at right angles to the former; thus demonstrating, by actual experiment, that an electric current communicates magnetic properties, by induction, to such bodies in the vicinity as are susceptible of acquiring them. Prof. Oersted thus proved that there exists a reciprocal action between electric currents and magnetic bodies, and this was the foundation of the whole science of electro-magnetism. The discovery of the magnetic properties of electrical currents was at first received throughout the world with unqualified astonishment, as all previous attempts to identify electricity and magnetism had been unavailing. It was soon ascertained that Prof. Oersted had opened a new field of research, and its fertility was manifested by the great variety of interesting facts speedily brought to light by the emulative labours of experimenters; in fact, so rapid was the development of discovery in this new field of Oersted's that it was very difficult, if not impossible, for those whose attention could not be exclusively devoted to the subject to keep pace with its progress.

With the knowledge of Oersted's discovery, it would naturally suggest itself to every person giving thought to the subject, that if a conductor connecting the dissimilar metals of an electrical battery possessed magnetic properties whilst so placed, then it would be fair to suppose that all the effects which can be obtained from a magnet should be obtained from a wire so placed, and their experiments would naturally be in that direction. Amongst the foremost labourers in this new field of research was Ampère; who soon discovered that when two metal bodies are suspended or supported so as to be capable of moving either towards or from one another at the time that electrical currents are passing through them, they manifest a mutual attraction or repulsion, according as the currents are moving in the same or opposite directions. This phenomenon Ampère called electro-dynamics. M. Arago in France, and Sir H. Davy in England, about the same time made known, that if a metal wire, while being traversed by an electrical current, be plunged into iron filings it will retain around it a considerable quantity of the filings in the form of a cylindrical mass, the thickness depending on the strength of the current, and that immediately the circuit is broken the filings fall. This phenomenon further proved the magnetic properties of the wire while under the influence of an electric current. The following notes are from results of similar experiments which I have made in this direction:—The current must be of great strength to produce an appreciable effect; for instance, five ampères through a copper wire ·018 of an inch diameter. The larger the diameter of the wire the greater must be the current strength. Two Grove cells were sufficient to produce the effect with a very short length of wire, the greatest weight supported at any part of the wire being about one grain. Very fine iron filings settled round the wire, giving it the appearance of a circular brush. Copper, iron and aluminium all gave identically the same results, but with tin, zinc and lead, the necessary

current could not be used on account of their low melting point. Arago and Davy also found that a steel needle became more strongly magnetised if the magnetising wire were bent into a helix and the needle placed in the axis of the helix, instead of the conductor remaining rectilinear.

The knowledge of this fact led to discoveries still more startling, for it was soon found that, if a rod of soft iron were placed in a helix formed of a wire of any conducting metal covered with an insulating material, a feeble current was sufficient to impart powerful magnetic properties to the iron rod, more especially if the rod were formed in the shape of a horseshoe so as to permit of both ends being used to attract the same substance. The magnetisation was instantaneous, appearing immediately the helix was connected with the battery, and ceasing, almost entirely, as soon as the circuit was broken. Such an arrangement was called an electro-magnet, and this discovery caused a great advance in the science of magnetism, for it furnished a means of acquiring immense, if not an unlimited, magnetic power.

Experimenters soon gave their attention to determining the conditions most favourable to the development of powerful electro-magnets, and the published results of some of their labours are so remarkable that it cannot be deemed unjust to suppose that their ambition to excel each other took possession of their imagination and left their reason unemployed. However, some of their experiments produced very curious, interesting, and valuable results. For instance, it was found that if a helix of insulated copper wire be placed horizontally, and one end of a rod of soft iron be presented at one end of the helix, it will be attracted into the helix and place itself so that its centre coincides with that of the helix, the result being the same whether the rod is shorter or longer than the axis of the helix. Again : a ball of soft iron of any diameter, providing it is not too large to enter the helix, when placed at the opening of the helix and being free to roll upon a very horizontal plane, in like manner rushes in and stops at the centre. So powerful can the action of a helix of this description be made, that if a magnetised needle or bar be placed within it so as to rest upon the lower portion of the helix, the moment the battery is connected to the helix the needle or bar will place itself in the axis, and so long as the circuit is maintained, remain suspended in the air in opposition to the force of gravity. In the centre of a vertical helix connected with a powerful battery, I have so suspended a rod of iron three feet long and 1·25″ in diameter, totally free from any material connection or support.

A helix of insulated wire enclosing an iron core and electrically excited, not only makes that iron a magnet, but is itself a magnet, and has a sphere of magnetic lines of force surrounding it independent of the lines of force given out by the iron which it surrounds, and the more intense the current passing through the helix the more intense will be the magnetic lines of force. This should be borne in mind when experimenting with helices or iron rods separately or combined. The law of action and re-action being equal and opposite, it might be expected that, as electricity produces magnetism, so, conversely, magnetism ought to produce electricity; thus, no doubt, reasoned Faraday, and the results of his experimental research in that direction brought to light several most valuable discoveries. Faraday wound a certain length of insulated copper wire round a cylinder of wood, and over this helix he wound a similar lengh of insulated wire. One of these helices he connected with a galvanometer, and the other with a voltaic battery; when the battery contact was made he noticed a sudden effect at the galvanometer, and a similar effect when the contact with the battery was broken, but in the opposite direction to the first deflection. This and similar phenomena Faraday called Volta-electric induction. He then wound similar lengths of insulated copper wire separately on to sections of a welded ring of soft round bar iron. When one of these helices was connected to a galvanometer, and the battery to one of the other helices, much greater results were obtained than with helices wound on wood. When a charcoal point was fixed to each end of the wire of one helix, and these points were brought close together, a minute spark could be perceived each time contact with the battery was made with one of the other helices. He also found that whenever the end of a magnet was passed suddenly into or out of the centre of a hollow helix of wire connected with a galvanometer, strong deflections were produced, but the direction of the deflection depended on the movement of the magnet; when entering the helix the galvanometer was affected in one direction, and when leaving it was affected in the opposite direction. The same results were obtained if the magnet were fixed and the helix movable. This agency, excited by ordinary magnets, Faraday called magneto-electric induction. Thus Faraday proved that electrical currents can be produced by magnets the same as magnetic effects are produced by electrical currents, but he believed they differed in one important respect, viz., that time is required for the development of magneto-electric induction, whereas he considered volta-electric induction to be instantaneous; but the latter is not borne out by the results of my published experiments on volta and magneto-electric induction. It was while engaged in those experiments that Faraday coined and circulated the terms "line of magnetic force," or "magnetic lines of force," "magnetic curves," "line or lines of electric force," "magnetic or electric fields," &c.

Magnetism has ever been a fertile field for hypothesis, and the discovery of electro-magnetism increased rather than diminished the confusion created by the number of theories that were promulgated to account for so remarkable a phenomenon. If the reasoning of some had been correct, it would have been necessary to have ignored the fact that man cannot create, destroy, or in any way alter the mysterious power with which the Almighty has endowed matter, which power is designated, for the want of more knowledge, gravity, heat, light, electricity, magnetism, and so on.

The analogy which exists between the phenomena of magnetism and those of electricity are such as to warrant the suggested probability that the theory which applies to the one might, with equal justice, be attributed to the other. Thus arose the one-fluid theory of Œpinus for magnetism, which is similar to Franklin's theory of electrical induction. The foundation of the hypothesis of two magnetic fluids, which is in many instances similar to Du Faye's two-fluid theory of electricity, was laid by Coulomb. Faraday assumed that all the particles of matter were *not* polar in their normal state, but became so by the influence of charged particles when either in contact or in sufficiently close proximity to them, the particles thus polarised being in a forced state, and endeavouring to regain their normal or natural condition. Thus his hypothesis that induction, which always precedes conduction, is an action of contiguous particles consisting in a species of polarity. The great similarity of action between common magnets, electro-magnets, and electric currents furnishes powerful reasons that the action is the same in all cases; consequently the theory which applies the more correctly to the one should apply equally to the other. The further I extend my experimental research either in electricity or magnetism, the more strongly do I become converted to the belief of the correctness of Faraday's views concerning these matters; but I am inclined to differ from him on one most important point, for I assume that each atom of matter possessses in itself all the properties of a magnet, and, consequently, emits its own lines of force; and, I further believe, that the molecular attraction known as "cohesive force" is one of the results of this all-pervading system of polarisation. Each atom existing in a polarised state, it follows, I think, that the outer ones, which form the surface of the earth, affect and are affected by the atoms of the air and other atoms in contact or in close proximity to them, and thus the system of polarisation is continued in curved lines throughout the whole atmosphere surrounding the

earth, and constitutes what is termed "terrestrial magnetism." If this be so, it therefore follows that all particles of matter, solid, liquid, or gaseous, are in a polarised state, and consequently emit lines of force.

These lines arrange themselves so as to be in a position symmetrical to the lines of force emitted by any other body, the earth's magnetic field for instance; that is to say, the strongest polarised lines will control the weakest, and direct and attract them, as illustrated by gravity. But when forced from their normal position of equilibrium by any external agency, it depends on the energy of the same whether heat, light, or sound be developed separately, or the whole three combined, as instanced by the heat generated in a magnetic field, the light produced from it, the hum of the insect or other more significant causes, or the three combined, as in the lightning's flash and the thunder's peal. As soon as the cause of each phenomenon no longer exists, the lines of force regain their normal condition, and all is once more quietude.

All matter conducts electricity, but not in the same degree, in fact it is difficult with some substances to detect their conductibility. With an increase of temperature gutta percha and such like dielectrics decrease in resistance, while with copper and other good conductors their resistance is increased under the same conditions. All matter does not polarise to the same degree; in fact, with our present knowledge of instruments for this line of experimental research, we are only able to speak in positive terms of comparatively few; but with these few we learn that temperature affects polarisation, and, perhaps, if sufficient variation of temperature could be obtained, it might be found that, under certain conditions, lines of magnetic force might be made manifest from bodies which at the present time we least suspect. I assume it is not possible to decrease the normal amount of polarisation of atoms, but that it can be increased up to a certain point by external influences, as instanced by the conducting properties of matter, which is, I think, the result of forced polarisation. But if an attempt be made to exceed the maximum specific capacity for polarisation of any combination of atoms forming the material under experiment, then will be developed all the phenomena just mentioned, and eventually, if carried too far, disruption occurs, a phenomenon well known to electricians, and manifested generally in the destructive effects of lighting.

Of course, in a mere pamphlet such as this, it is impossible for me to notice all that has been done by eminent physicists in advancing our knowledge of magnetism. My object has been to give a simple and brief outline, and in so doing to call attention to some of the most prominent points in connection with the history of the same, which, perhaps, might prove of service to the earnest student, in leading up to a better understanding of the experiments which I am about to describe.

Having now completed my task so far, I will at once proceed to give the results of some experiments I have thought it necessary to make, as opportunity offered, to assist me in my search after the truth concerning that most wonderful phenomenon of nature which we call magnetism.

(*To be continued.*)

FRENCH ACADEMY OF SCIENCES.

THE BORDIN PRIZE.

THE question proposed for 1882, and postponed to 1885, was as follows:—"To find the origin of atmospheric electricity, and the causes of the great development of electric phenomena in storm-clouds."

Fourteen memoirs in reply to this question have been addressed to the Academy this year. Some of them are long and important investigations on the question proposed. Most of the authors of these memoirs begin by discussing the various hypothesis concerning atmospheric electricity, and indicating which, in their opinion, ought to be accepted; this portion of their work is, in general, the most elaborate. As for the causes of the great development of electric phenomena in storm-clouds, they have been studied imperfectly, or not at all, and in this respect the memoirs leave something to be desired.

The printed memoir of M. Edlund, Professor of Physics at the Swedish Royal Academy of Sciences (No. 1 of the competitors), having as its title: "On the origin of the atmospheric electricity of thunder and of the aurora borealis," has especially attracted the attention of the Commissioners by the novelty and originality of the views which it contains.

M. Edlund describes the development of atmospheric electricity to certain effects of electro-magnetic induction, which he terms unipolar induction. The fundamental experiment upon which these effects are based is that if a hollow conductive cylinder surrounds the one half of a permanent magnet, the axis of which is the same as that of the cylinder, the second half of the magnet being outside at the moment when the cylinder is set in rotation, there is produced in the direction of each of the generators of the cylinder a difference of potential depending on the direction of the rotatory movement, but which remains the same, and of the same direction, whether the magnet is fixed or movable, at the same time as the cylinder.

Setting out from this fact, and likening the earth and the upper portion of the atmosphere to conductors which turn without ceasing, and which are submitted to the influence of terrestrial magnetism acting in a constant manner, the author concludes that the air tends to take a positive charge and the earth a negative charge; further, this positive electricity is soon conveyed into the upper regions of the atmosphere, whence it directs itself towards the poles under the influence of this same magnetic force.

The air at the surface of the ground is not a conductor, but in consequence of the decrease of pressure its conductivity becomes sensible in the higher regions, which permits the production of the foregoing effects. Moreover, in those regions appears the aurora borealis, the electric origin of which is beyond doubt.

The positive electricity of the air, and the negative electricity of the earth, according to this hypothesis re-combine so as to give rise to an incessant movement of electricity, kept up by the inductive action of terrestrial magnetism. The author examines how the effects vary according to latitude, and he shows that the resistance to the neutralisation of the electricities, strong in the equatorial regions, diminishes on approaching the poles, so that in the former there are disruptive discharges, whilst in the high latitudes there are produced slow, almost continuous discharges.

M. Edlund has determined experimentally what may be the magnitude of this terrestrial electro-magnetic induction exerted on the earth and on the atmosphere. According to his estimates a difference of 1 metre in height in our latitudes should give rise to an increase of positive potential equal to about 0·023 volt, or 2·3 volts for a difference in altitude of 100 metres. This value is far less than that given by experiment when we study the distribution of electricity in the atmosphere under a clear sky. M. Edlund supposes that there is produced in the upper regions an accumulation of electricity which may give rise to the effects of storms and to the different phenomena which we observe.

The hypothesis proposed by M. Edlund is ingenious and developed with ability, but in the present state of science we cannot affirm that it accounts for the grand natural phenomenon the explanation of which is not yet complete. The Commissioners whilst making reservations in this respect, wishing to testify to this *savant* the interest which they take in his researches and to reward an original work of which they appreciate the value, propose to the Academy to award him the prize.

The proposal was adopted.

The "Grand Prize" of the mathematical sciences, consisting of a medal of the value of 3,000 francs, proposed for 1884 is postponed to 1886. It is required:

"To improve in some important point the theory of the application of electricity to the transmission of work."

Memoirs must be sent to the Secretary before June 1st, 1886. They must have a motto or device, which is to be repeated on a sealed note containing the name and address of the author. The note will not be opened unless the prize is adjudged to the accompanying memoir.

LAYING A CABLE.

IT was not much of a cable, after all, and its laying was no great performance, although forty years ago it might have been considered a marvel.

Science, in its so-called practical aspects, is now advancing in parallel lines; and these are so numerous, and some of them so far-reaching, that most men are unable to follow along more than one or two. This fact has suggested the idea that there may be something of interest to many in a description of this cable, and of the operation of putting it in the water.

It does not connect us with any foreign country; it does not complete the girdle round the earth: it is modestly content to serve as the link which joins the intelligence of the rest of the world with that of the interesting and important islands, Martha's Vineyard and Nantucket, where formerly the influence of the whale prevailed over all else, but now, alas! tributary to the state of Massachusetts, from which comes good government, and to the Standard Oil Company, from which comes petroleum, that arch

enemy of the whale trade. But exclusiveness, even when aided by insulation, must give way to the progress of events. A glance at the map will show the nature of the forces operating in this case. Vineyard Sound is the great highway of the coasting trade. Thousands of vessels of all kinds pass through it every year. The harbours of Vineyard Haven (correctly named), Tarpaulin Cove, Lambert's Cove, &c., afford shelter for hundreds during rough weather. Wrecks are, unfortunately, not infrequent; and a visitor from the outside world is likely to see in the simple but perfectly neat and thrifty looking home of the fisherman-farmer a carved and upholstered chair, or something of the kind, which is referred to with no little pride as a relic from the wreck of some passenger steamer which went ashore with the loss of many lives and much property upon the coast near by.

The principal and sufficient reason for asking for a special appropriation from congress to secure telegraph communication with the mainland, was that stations of the U. S. signal service might be established on the islands, and particularly that danger signals might then be displayed from the more prominent points for the guidance of the numerous sailing craft constantly passing through the sound. Some years of effort were rewarded with success at the last session, an appropriation of forty thousand dollars having been made for the purpose of laying the necessary cable, amounting in all to less than thirty miles, and for erecting the land lines, display stations, &c. The work has been done, therefore, under the direction of the chief signal officer.

The cable was made in London, and shipped to New York in the hold of a steamer, coiled in two large tanks especially built in the steamer for that purpose. It fortunately happens that the gutta-purcha insulation, used almost exclusively for submarine cables, is improved and preserved by being kept damp, cracking and deteriorating when dry. For this reason it is necessary to keep the cable in tanks during its passage, so that it may be kept covered with water. The conducting part of the cable consists of seven copper wires, each about ·028 inch in diameter, six being twisted about the seventh as a centre. The resistance of this conductor was not to exceed thirteen ohms per nautical mile, and it fell considerably short of that upon being measured. This copper core was covered with three or four layers of gutta-percha, until the diameter of what might be called the cable proper was a little more than a quarter of an inch. Such a cable would scarcely last while it was being put down, and it is therefore necessary to put an "armour" upon it, so that it may be able to endure the destructive agencies to which it is likely to be subjected. The gutta-percha-copper core is wound with two or three layers of heavy jute twine, and this, again, with twelve number five galvanised iron wires laid on spirally. The result is apparently a strong iron rope about an inch and a quarter in diameter.

An examination of the cable was made in New York City, before its removal from the tanks referred to, for the purpose of seeing that its insulation was still intact. It was then transferred to a barge lying alongside, from which it was to be laid, and in which it was towed through the sound to Vineyard Haven. Its arrival at this place caused little less than a sensation. The first section of the cable was to be placed across Vineyard Sound; and, although not the longest, it was the section likely to cause the greatest anxiety. In fact, the Western Union Telegraph Company has several times tried to place and maintain a cable from West Chop Light on Martha's Vineyard to Nobska Point on the Mainland, but their efforts have not been altogether successful. The damage to a cable across the sound arises from two sources. The tidal current is strong, at some points nearly three miles per hour; the seaweed, which is carried back and forth by this current, is caught on any suspended or exposed part of the cable, and twisted around it until huge, solid masses are attached to it, which offer so much surface to the swift current that the cable must give way under the strain. The other source of danger is quite as disastrous, and nearly as uncontrollable. It is in the dragging of ships' anchors across the line of the cable. In this way the cable is caught in the anchor and brought to the surface when the latter is hoisted. A little intelligence, combined with good nature, would enable the shipmaster to release the cable and drop it uninjured; but more frequently, in his annoyance, he will deliberately cut it in order to escape, although release without injury could be accomplished in less time. In putting in this cable it was desirable to locate it so that the chances of damage from both of these sources might be reduced to a minimum. To this end the officers in charge of its laying did not need to seek advice from persons familiar with the waters, for it was freely offered by every inhabitant of the islands. The multitude included a few old sea-captains, who seemed to know every foot of the coast, and to understand the nature of the bottom of the sea; and it is believed that their words were words of wisdom. The route selected lay across the sound several miles to the westward of that already referred to. It is undoubtedly freer from probable damage arising out of the anchorage of vessels, but time alone can determine to what extent.

Every thing being in readiness, the barge was towed to the starting-point, which was the northern terminus of the cable on Naushon Island. As there was a good deal of a "sea" running, it was not possible to approach nearer than twelve hundred or fifteen hundred feet from the shore. The tug was anchored, and the barge was allowed to drift in a few hundred feet farther. A stout rope, an inch and a half in diameter, was then attached to the end of the cable, eight or ten men were put into a boat, and the other end of the rope was carried ashore. The end of the cable was dropped overboard, and the operation of pulling it to the beach began. This was finally successful, and the shore end was made fast to a stout post which had been erected for the purpose. All hands came on board, anchor was weighed, the barge made fast to the tug, and the journey across the sound was begun. The cable lay in two great coils in the barge, and dropped into the water over the stern. It passed around and over a couple of large reels or drums, where a large pulley-brake was applied to it in order to regulate the tension to which it was subjected. To one of the drums a counter was attached, so that the rate at which it was paying out could at any time be determined. Wind and tide opposed each other, and the rate of sailing did not exceed five or six miles per hour. The opposition of wind and tide was favourable to a straight course, and good pilotage secured a run across which undoubtedly put the cable down in almost exactly a straight line from the point of departure to the southern terminus on Martha's Vineyard. At this end the landing was a little more difficult. A rope was first carried ashore, its length measured as it went out, to determine where to cut the cable that it might reach the beach from the anchorage. On its next trip the little surf boat carried a small, weather worn 'A' tent, a rough bench, batteries, galvanometers, resistance coils, and two shivering signal service men, who were to test the cable as soon as it was landed. A rude testing station was soon established amid the hillocks of sand, and the instruments were in position when the cable was at last landed, and secured to a portion of the wreck of an unfortunate vessel that had stranded upon the shore many years before. But the high winds were still rising, darkness was coming on, and the captain of the tug, declaring that he had had enough of cables for one day, ordered all hands on board forthwith. It was impossible to leave the instruments in that condition, and the prospects for a night on the beach seemed good, when the hospitality of the owner of the one house within sight brought relief, furnishing a storehouse for the appliances, a well supplied table for keen appetites, and a waggon ride at night through the woods to the hotel, seven or eight miles away.

On the following day the termini were again visited, the ends properly secured, and the cable tested. A trench was dug in the sand down to low water mark, in which the cable was buried. At a point above high tide on the beach a strong post was erected, to which the cable was secured by means of a heavy chain; from which point, still underground, it was carried higher up the sand hills on which it had been landed, to the foot of an ordinary telegraph pole. It extended up the side of this, being enclosed in a box until it reached the top, where it entered the cable box proper, the end being secured to a binding screw ready for connection later with the land line. Some of the party had been sent to Naushon Island, carrying with them an ordinary telegraph instrument and key. By previous agreement it was to be connected with the cable at once on the arrival of the party. A few cells of battery and a similar instrument were joined to the end on Martha's Vineyard, and the two expeditions had been timed so accurately that almost instantly responsive ticks proved that intelligence was at work on the other side. Much interest is often felt in the first message transmitted through a cable or telegraph line. Brushing aside the romance of the thing, it is safe to say that in nine cases out of ten the first message is that which traversed the river first on this occasion, being simply "Do you get me now?" After some further interchange of compliments, the operator on Naushon was directed to seal up the end of the cable by covering the exposed wire with gutta-percha. This having been done, communication ceased, and the insulation was tested. A number of battery cells were joined "in series" to the galvanometer, which was a delicate instrument of high resistance, with a reflecting mirror, and to this the end of the cable was attached. The test was practically an endeavour to force the current through the gutta-percha insulation, the amount of the leak being measured by the deflection of the galvanometer needle. It had been demanded of the cable that it should show an insulation resistance of at least two hundred and fifty megohms per mile, and it greatly exceeded this number when tested.

A few days later, when wind and weather were favourable, the island of Nantucket was connected in a similar way with Martha's Vineyard, the cable taking a sweep out into the sea to avoid shoals; and finally a short piece, about a mile in length, was made to connect Naushon, by way of the little island Uncatena (always "Uncle Timmy" at home), with Wood's Holl, and thus was completed the union of these islands with the mainland which it is hoped may last for many years.—"M.," in *Science*.

The Edison Telephone Patent in Canada.—The taking of evidence before the Deputy Minister of Agriculture, on the application of the Telephone Manufacturing Company of Toronto, has been concluded and decision reserved. The application is to have the Edison telephone patent, now held by the Bell Telephone Company, declared void because of the importation, non-manufacture and refusal to sell by the Bell Company. The Bell patent proper was annulled last year, but the Edison patent still holds good, and, as the Bell Company has brought an action against the Telephone Manufacturing Company for an infringement of the last-named patent, this application is made to set it aside.

NOTES.

Electric Lighting of the Blackpool Winter Gardens.—The directors of the Winter Gardens at Blackpool, having, as we have already announced, decided to light the gardens by electricity, have put the installation in the hands of Mr. M. Holroyd Smith, well-known in connection with the electric railway at Blackpool, and that gentlemen is now preparing plans and specifications. Tenders, we are informed, will be invited shortly.

Electric Lighting in the Leeds Town Hall.—The Electric Lighting Committee of the Leeds Corporation has decided to illuminate the Victoria Hall by means of arc lamps, at a cost of about £450. Secondary batteries, by the Electrical Power Storage Company, are to be provided, and these will be charged by dynamos which the Corporation already has in its possession in the basement of the Municipal Buildings. The current is to be carried from the Corporate Offices to the Town Hall along a subway now existing in Calverley Street, and thence into the "false" roof of the Victoria Hall, from which will be suspended eight 2,000 C.P. arc lamps with ornamental pendants. A small sub-committee visited Manchester to see several lamps tried, and they selected the Brockie-Pell. As the "electroliers," by means of which the Victoria Hall was lighted by Messrs. Crompton & Co. on the occasion of the last musical festival have not been removed, only a portion of the new arc lamps will be fixed to begin with. It is intended at the outset to hang two of the arc lamps in the middle of the hall, early in January, and before the scheme is completed the committee, and, possibly, the public, will be afforded an opportunity of witnessing the effect produced. The pair of twelve horse (nominal) power gas engines, which supply the dynamo power for illuminating the Municipal Offices, are at present standing idle all day, so that by the making of a battery installation for the Victoria Hall, the Corporation will not require any additional engine power, but will be able to fully utilise that which they already have, without extra outlay upon machinery. The two engines are coupled, so that should one dynamo break down, the whole of the power can be run upon the other dynamo. The preparations for putting the committee's project into execution, which are being carried out under the superintendence of the borough engineer's department, are approaching completion, and when the lamps come to hand they will be put in position and set going without delay.

Electricity in the Royal Navy.—An important addition to the active list of the Royal Navy has been made by the completion for sea at Sheerness of the new unarmoured composite corvette *Pylades*, which was launched in November, 1884. She has a displacement of 1,420 tons, and is fitted with machinery of 1,000 horse-power. Her armament is more powerful than that of her sister ships, and consists of 14 5-inch steel breechloading guns, mounted on the Vavasseur carriages. The *Pylades* is also equipped with Gardner and Nordenfelt machine guns, and the electrical machinery for discharging the spar torpedoes. The total cost of building and equipping the vessel is about £75,000.

Shop Lighting by Electricity.—An experiment, the object of which is to test the utility of the electric light for retail shops and private houses, is now being made in Wade Lane, Leeds, where the premises of Messrs. Walsh and Son, paperhangers, H. Cooke, tailor, and E. Yewdale, chemist, are lit in circuit from a dynamo worked by Mr. E. Walsh, engineer. It is stated that in this instance experience shows that the cost of the electric light is not so great as it has been represented, while those who have made the experiment are satisfied with the result so far as the steadiness and brilliancy of the light are concerned.

Electric Lighting in Middlesborough.—An industrial and art exhibition has just been opened in the Cleveland Hall, Middlesborough. The building is lighted by the electric light, seven 1,000-candle arc lamps being in use. Four of the lamps are hung in the upper hall, two in the lower hall, and one at the entrance to the exhibition. The motive power is supplied by an 8 horse gas engine, and the dynamo is a Brush six lighter.

Woodhouse and Rawson Lamps.—Les Fils de Peugeot Freres write to us from Valentigney (Doubs), regarding these lamps:—"In answer to your remarks respecting incandescent lamp tests, we are glad to state that a few Woodhouse and Rawson's, tried by us, gave good results as regards duration, economy, &c. We made very thorough and careful tests lately, during a run of 2,000 hours, with different makes, on our 1,200 Edison lamps station, and had we tested a few more Woodhouse and Rawson lamps, we might have been able to state very correctly on their general qualities."

Electric Lighting in Chicago.—Electricity for lighting is coming to the front in this city, says the *Chicago Manufacturer*. A careful estimate, based upon an extended experience in the use of the incandescent plant elsewhere, and upon the quantity of light actually used in the city hall and tunnels each day, would indicate that the cost of this light to the city will be the equivalent of gas at from 65 to 70 cents. per thousand feet.

Electric Light Shares.—Is the confidence of the public in electric lighting undergoing resuscitation? A sudden activity has sprung into existence in the share dealings of several electric lighting companies; but there is no self-evident cause to which we can readily ascribe this movement. We know that several companies have been quietly doing a steady business, and it is just possible that one or more will pay a dividend shortly; whether that dividend, however, will be entirely upon business done or not we should not like to say. Then it is pretty confidently anticipated that when Parliament settles down, a considerable amelioration of the grievances of those who suffer under the Electric Lighting Act will be brought about; and this might well influence the public in their purchases. The extension of Brush lighting in the City, too, has probably had an effect upon those who are on the alert for "a good thing." Perhaps the Maxim-Weston shareholders will flatter themselves—and their chairman—by tracing the renewed activity to the election of Mr. Hugh Watt to Parliament. At any rate, whatever the cause, let's hope it is not a rattling of dry bones, and that this will prove a happy augury for the electrical industry during the year that is now upon us.

The Dolbear Telephone Case.—Prof. A. E. Dolbear, writing to the *Scientific American*, says:—"In the *Scientific American* of November 28th, in the article on the Reis telephone, there is a quotation from the judgment of Judge Gray in the Dolbear case, in which is the statement that it was not denied that 'Bell was the first inventor of a speaking telephone.' This statement is ambiguous, and may be understood in two ways. It was admitted that Bell invented *a* speaking telephone. It was not admitted that Bell was the inventor of the first speaking telephone. A distinction was made between the telephone invented by Reis in 1861 and the telephone invented by Bell in 1876 as being unlike in principle though having the same function, namely, to transmit speech. It was affirmed at the outset that Bell was not the inventor of the first speaking telephone, but that Reis invented one long before, and this was reiterated time and again in the case. Judge Gray knew this, and he carefully framed his statement so as to convey the impression that admissions had been made which had not been made, and yet if the sentence was carefully scrutinised, it would be found to be rhetorically correct—a case of

trifling with the language which one would not look for in a United States judge. The whole trouble lies in the use of the word *first*. It was admitted that Bell was the first inventor of (a particular kind of) a telephone. It was emphatically denied that Bell was the inventor of the first speaking telephone, and it was asserted that Reis invented a speaking telephone fifteen years before."

Proposed Telephonic Exchange in Stirling.—A meeting of gentlemen interested in the proposal to institute a telephone exchange in Stirling was recently held in that town, when Mr. A. R. Bennett, general manager of the National Telephone Company, spoke of the utility of the telephone, and explained that the proposed exchange would afford communication with the subscribers within a six miles radius from Stirling, the intention being afterwards to extend the communication to Glasgow, Dundee, Perth, &c. Mr. Mitchell Thomson, of Edinburgh, a director of the company, also addressed the meeting, and at the close several gentlemen signified their willingness to join the exchange.

Interruption to Telegraphic Communication.—Last Saturday afternoon a singular accident occurred at Newbury, resulting in the interruption of telegraphic communication between the metropolis and Bristol and other places in the West of England. A large walnut tree was being removed by a traction engine from one part of Newbury to another, and when passing through Northbrook Street the branches caught the line of wires which cross the thoroughfare and snapped them.

The Telegraph in China.—At the present moment an important line of telegraph is being constructed along the southern borders of China, through the provinces of Kwangtung, Kwangsi, and Yunnan. Starting from Nanking, in Kwangski, where it joins the Canton-Lungchow line, it will extend for nearly 600 miles to Nung-lik, in South Yunnan, running for half the distance along the Yukiang, the name of the Canton River in its upper course.

The Mackay-Bennett Cable Company.—The *New York Herald* of December 24th contains the following editorial :—"At the close of to-day, the Commercial Cable Company will be one year old in the public service. It started with rates 20 per cent. below those of the monopoly or pooled cables controlled by Jay Gould, and those rates have never been changed. The pooled cables were forced to reduce at once their charges to the figures of the new company. Thus the cable business for the year 1885 has been done for four-fifths of the cost under the monopoly of the previous year. This means that the cable-using public has been saved about $1,000,000 of the sum it formerly had to pay. The commercial community was quick to see and to avail itself of the advantages of the direct connections and improved construction of the new cables. From the beginning the enterprise has received the heartiest encouragement and support. The Commercial Cable Company during the year has never for a moment lost communication between the two continents, the commercial and financial interests of which are becoming more intimate every day. Improvement in the speed and accuracy of the cable service has done much and is doing more to increase this intimacy. It is but a few years since the delivery of a message across the Atlantic in forty minutes was regarded as marvellous. To-day by the Commercial cables messages are transmitted from this city to London in two-and-a-half minutes. Value of speed in arbitrage and other transactions calling for haste is obvious. It is not at all uncommon to have a message sent and the answer received within the space of ten minutes. The public is to be congratulated upon this remarkable annihilation of distance, and upon the numerous advantages which are certain to follow from it."

Atlantic Cables.—The New York *Electrical World* says in a recent issue :—"One of our English contemporaries given to the use of strong language, goes out of its way to advise 'that not a single farthing be invested in any new Atlantic cable company, as it is impossible that any return can be realised from such investment ;' and it emphatically protests 'against any attempt being made to obtain money from the public for this purpose.' There can be no doubt that the present number of Atlantic cables is amply sufficient for the traffic ; it was so even before the construction of the Mackay-Bennett cables, but we are free to say that the money invested in the latter is paying a fair dividend. Of course, cables with plenty of watered stock, find these times of competitive rates very dreary, and thus far we think the new Atlantic cables have had the best of the fight. The gratuitous advice of our contemporary seems, therefore, to be a plea for the protection of the old companies from further interlopers, rather than altogether disinterested warning. Certain it is that the public will not suffer by the construction of new cables."

Domestic Electric Lighting.—Mr. Phipps, F.S.A., has done good service by making public the results of a twelvemonth's trial of his electric lighting installation at Mecklenburgh Square. Surely many private householders will now follow this gentleman's example, domestic lighting being, on the face of it, both easy to manage and cheap to maintain.

Magnetism.—In our present issue we commence the republication of a pamphlet on "Magnetism," from the pen of an indefatigable worker in this interesting study. A careful perusal of this will well repay even the scientific reader, who will relinquish his task with the feeling that he has added not a little to his store of knowledge.

Dynamo Tests.—The letter of Mr. Chas. F. Heinrichs, which he has asked us to publish, is of an interesting nature, but it is more than probable that ill-disposed persons may look upon it as a means of ventilating the merits of his own machine, rather than as an impartial criticism upon the tests of the Franklin Institute. And, indeed, we think the matter at issue might have been best commented upon without any reference to outside machines.

Archimedes Redivivus.—A correspondent signing himself "Hiero" having now favoured us with his identity, we would call attention to his amusing lines on a well-known electrical tramcar system, which may be found in our Correspondence columns.

Electric Locomotion.—The first successful attempt at trial trips of the new cable car was made recently in Denver, Col., over a portion of the track of the Denver Electric and Cable Railroad Company on Fifteenth Street. The car ran a considerable distance, and, states the New York *Electrical Review*, at the satisfactory rate of eight miles an hour. A dynamo of 20 horse-power furnishes the motive power for the car. Prof. S. H. Short, of the Denver University, has worked very hard to make his invention a success, and his efforts seem to be already reaping their reward. The company hoped to get its cars running in a month or six weeks. The car which is now being used in making trial trips is shaped and fitted up very much like an ordinary street car, and is fully as handsome in its style and appointments as any street car in Denver. It was made by Woeber Brothers, of West Denver. The dynamo and other machinery, which is located in a building near the corner of Fifteenth and Tremont Streets, and which is used to propel the car, was made by F. M. Davis, of Denver, and all the plant and material used by the company will be of Denver manufacture.

The Determination of Melting Points.—A simple contrivance has been introduced for the determination of melting points, states the New York *Electrical Review*, the apparatus consisting of a small platform of thin ferrotype iron or silver, having an opening for the reception of a thermometer bulb, and a small indentation or depression. In the latter, a very small quantity of the substance to be decided upon is melted, and, while still liquid, a thin platinum wire, bent like an L and fused into a glass float, is immersed in the liquid and held there until the substance solidifies. A thermometer is then inserted in the opening, and the whole apparatus plunged under mercury; the latter is gradually heated, the thermometer carefully watched, and as soon as the substance melts, the float rises instantly, the temperature being now noted. Stirring is by this arrangement unnecessary. The whole of the material is surrounded with mercury, and the attention can be concentrated on the thermometer, and the most accurate results thus obtained.

A New Method of Propelling Vessels.—Messrs. Samuel and John A. Secor, of Brooklyn, have devised a method of forcing gases against the water for the propulsion of ships. The system will soon be given a practical trial, the ship with which it is to be made having recently been launched. She now only awaits her machinery. The method employed, as stated by the New York *Electrical World*, consists in compressing a small quantity of air, which is then impregnated with petroleum spray. This is then exploded by an electric spark, and the large volume of gas generated is forced out at the stern. Petroleum being the fuel used, and only small quantities of it being required to form the explosive mixture, it is hoped to reduce the expense usually attending coal consumption to a minimum. It is expected that within a few weeks the boat will be ready for a trial.

Lightning Conductors in Philadelphia. — Prof. George F. Barker has recommended to the Public Building Commission of Philadelphia, as a protection to the 500-foot tower of the new City Hall from lightning, that two complete and continuous metallic conductors be placed on the tower from the base to the summit. He also suggested that the flagstaffs now erected on the pavilion be made to terminate in a number of sharp points. The metal of these points should have a high conducting power and a high point of fusion, not readily acted upon by atmospheric influences. The metal most available is said to be malleable nickel.

Sale of Machinery.—Messrs. Wheatly Kirk, Price and Goulty announce an important sale of wood-working machinery, boilers, lathes, &c., on Thursday, January 7th, at the large warehouse recently occupied by Messrs. Jackson and Graham, Ogle Street, Fitzroy Square, W.

"Impracticable and Unprofitable."—"The queerest thing about all this electro-motor business for railroads is the credit claimed for electricity," says the *Mechanical Engineer*. "This is an agent, as much so as the cable on cable railroads, and it would be quite as proper to call the cable the prime mover as it is to assert that electricity does the work. A steam engine does the work, for without it electricity would have no existence. Take away the steam engine and the railroad is inoperative, by electricity or anything else. As there is always a loss in transferring power from the source of it to an agent, the use of electricity on railroads is impracticable, and will be unprofitable, until it can be produced independent of steam."

We were not aware that anyone proposed using electrical propulsion on railroads in their proper sphere; but surely our contemporary will confess that locomotives are much more wasteful of fuel than a properly-designed stationary engine, which would be employed in connection with short tram lines, worked electrically?

Personal.—Mr. Jas. Swinburne notifies that he has now become connected with Messrs. Crompton's works.

The Queen has been pleased to confer the honour of Knight Commander of St. Michael and St. George on Col. Bateman-Champain, who is well known in connection with Anglo-Indian telegraph enterprise.

Telegraph Relays.—We shall publish in our next week's issue a paper on the above subject, which will be found of special interest to those engaged in telegraphic pursuits.

The Results of the Past Year.—We shall be glad to receive from electrical companies and firms brief reports of such of their work for the past year as they may deem it expedient to publish. At the same time, any intimation of work in hand and in prospect would form interesting items of news.

Seasonable Festivities.—The directors and staff of the Yorkshire District of the National Telephone Company gave a ball on Monday evening, the 21st ult., to the lady operators and other friends at the Technical College, Bradford. Amongst those present were Mr. G. A. Steinthal and Major W. H. Shepherd (directors), Major A. W. Lassen, Mr. and Mrs. Philipp, Mr. C. Philipp, Mr. J. C. Chambers (general manager of the company) and Mrs. Chambers, Mr. and Mrs. Michael Mullen, Mr. and Mrs. Walter Emmott (Halifax), Mrs. Frank Lumley, Mrs. W. J. Gray (Dewsbury), and Miss Marion Whitehead (Manchester). The following gentlemen acted as stewards:—Mr. F. Lumley, manager of the company's Bradford District; Mr. Ralph Mewburn, manager Leeds District; Mr. W. J. Gray, manager Dewsbury District; Mr. A. Ball, cashier, and Messrs. W. T. Davison and J. Holroyd, inspectors. The reception room, ball room and galleries were tastefully decorated with evergreens and drapery, whilst the band was screened from the ball room by a beautiful arrangement of foliage plants. Dancing commenced at 9 o'clock and was continued until 12 o'clock, when a supper provided by the Bradford Café was served. After supper several ladies and gentlemen went through a programme of songs and recitations which were much appreciated. After this dancing was resumed and continued until after three in the morning. Mr. Michael Mullen, shortly before the conclusion of a very enjoyable night, proposed a vote of thanks to the committee and to the givers of the ball for the entertainment so splendidly provided, a motion which was seconded by Mr. H. Storey and carried unanimously. Mr. Lumley, who responded in the absence of Mr. Chambers, said that he trusted this was the first of a series of such annual assemblies. The music was provided by Mr. Stocks Hammond's band.

The Palace of Delight.—Our readers will remember our note in the REVIEW for November 21st last respecting the contemplated Science and Art School and inaugural exhibition at Saltaire. We are now informed that Mr. Titus Salt has requested Mr. Holroyd Smith to put down an electrical railway in the grounds.

Obituary.—The Edinburgh correspondent of the *Times*, commenting upon the death of Sir George Thomson, who was a month ago elected to Parliament for one of the divisions of the city of Edinburgh, states:—"One of the most important of his public services was the prominent part he took in obtaining the transference of the telegraphs from private companies to the Government. The Edinburgh Chamber of Commerce was the first public body in the kingdom that took up the proposal earnestly, and that was due to the initiation of Sir (then Mr.) George Harrison, who was then and for many years one of its most active office-bearers. It was owing very much to his persistent zeal that the arrangement was carried out; and to him, therefore, the country is indebted indirectly for the benefits of the cheap and efficient telegraphy which it now enjoys."

Royal Institution of Great Britain.—The winter programme in connection with the Royal Institution opens with a series of Christmas lectures by Prof. Dewar on the story of a meteorite, and the list of lectures down till Easter next includes such names as those of Dr. Ball, Astronomer Royal of Ireland, whose subject is the astronomical theory of the great ice age; Mr. R. S. Poole, Mr. C. T. Newton, Prof. A. Gamgee, Mr. W. C. Roberts-Austen, Prof. W. Boyd Dawkins, Prof. Tyndall (who gives four lectures on light), Mr. Archibald Geikie, and Dr. Taylor, of St. John's College, Cambridge. The Friday evening meetings begin on January 22nd, when Prof. Tyndall discourses on "Thomas Young and the Wave Theory," and the programme of probable arrangements is one of sustained interest. The Royal Institution, as is well known, is an association of individuals who are attached to science and desirous to promote its advancement. It includes two laboratories for the promotion of chemical and physical science. In the physical laboratory the researches of Prof. Davy, of Prof. Faraday, and of Prof. Tyndall were conducted; while in the chemical laboratory Prof. Frankland made some of his most important researches in organic chemistry; and more recently Prof. Dewar has conducted his spectroscopic researches, and his experiments relating to the chemistry of the electric arc and the condensability of gases. Both forms of the electric light, the voltaic arc and the magneto-electric spark were, indeed, first introduced at the Royal Institution by Davy and Faraday. In addition to the public lectures and the weekly meetings of the members, there are a model room, containing scientific apparatus of historical interest and of present use; a library of about 50,000 volumes, a reading room for study, and a newspaper room. It only remains to be added that the institution is self-supporting and has never received any aid from Government.

Steel-Copper Electric Conductors.—It is many years since compound telegraph wires were introduced into this country from America and were tested experimentally, but, the combination being formed mechanically, the experiment resulted in failure. Since then a compound wire, consisting of copper deposited upon iron or steel, was tried in the States and many lines were run up with it and for a time it obtained extensive use; but with us the compound wire has never secured a footing, failure having resulted, the principal faults being the uncertainty of the joints, and the "local action" setting up at any exposed place, causing the destruction of the wire. We have recently heard, says the *Mechanical World*, of a compound wire in which the relation of the two metals is reversed, the steel surrounding the copper. The wire is stated to be drawn from compound metal, consisting of a hollow ingot of steel filled with copper. The results of tests of a No. 8 wire so made are said to be very satisfactory, but in practice we should expect the old results to follow. A good and durable compound wire for telegraph lines is much to be desired, as decreased resistance could be obtained at reduced cost.

Electrical Conductors and Transmitting Power.—The paper which we publish by Mr. Thomas Whiteside Rae, C.E., contains many useful hints and thoughtful comments, but we cannot accept his deductions. M. Marcel Deprez would not look for a return of 70 per cent. of his initial power, even when working under far more favourable conditions as regards economy than appears to be the case on Mr. Rae's line. It might, on a first reading of the fourth paragraph, be thought that this gentleman referred to loss between generating dynamo and receiver only, but this will be found on further inspection to be erroneous, the difference being clearly that between the initial horse-power required to drive the generators and the available useful horse-power at the receiving end. It is a pity that what might have been an excellent paper should be seriously discounted by statements such as that to which we have referred.

Indian Patents.—Correspondence has taken place on this subject in the *Times*. Mr. Ernest De Pass, Fellow of the Institute of Patent Agents, wrote:—"From advices just to hand from my correspondents in Calcutta I am informed that, by a recent ruling, the Advocate-General has decided to admit applications for Indian patents within 12 months from the sealing of the British patent for the same invention. This will, no doubt, be a boon to inventors who, in order to secure Indian patents, had previously to this ruling to make application for the same within one year from the date of the British patent. In effect this gives to inventors a considerable extension of the time within which to apply." Subsequently Messrs. Abel and Imray wrote: "Referring to Mr. De Pass's letter in the *Times* of to-day, we would caution patentees against placing too much reliance upon the ruling of the Advocate-General as to admitting patent applications within 12 months from the date of sealing of the British patent. About 12 years ago precisely the same decision was come to by the Indian officials, and was acted upon for about two years, when, without the slightest warning, the Government reversed the decision, having come to the conclusion that it was against the meaning of the Act. The result was that several of our clients—and doubtless a number of other patentees—who had kept their Indian applications back relying upon the above decision—had their patents refused because their applications were filed after the expiration of 12 months from the date of the British patent, and although we made strong representations as to the unfairness of this action of the Government, no redress could be obtained. In view of these facts we would strongly advise patentees to continue the present practice of filing within 12 months from the date of the British patent until the alteration has been duly legalised by an Act of Legislature."

Tramways in the United Kingdom.—The development of the tramway system in every part of the United Kingdom, as shown by a Parliamentary return issued on Saturday week, is very remarkable and encouraging. The length of line now open for traffic, which 10 years ago was 94 miles, now reaches 656 miles, while the number of passengers has increased from 89 millions in 1876 to 283 millions last year. During the same period the gross receipts rose from £791,000 to £2,094,000, the working expenses amounting to £1,600,000, which, deducted from the former, leaves available for dividend the handsome surplus of £494,000. In Ireland 85 miles of line are opened for traffic, and 70 miles in Scotland. In the three kingdoms the local authorities hold 187 miles, and private companies 623 miles. Locomotive steam engines have been tried and discontinued in Edinburg, Bristol, Brighton, and Paris, while Glasgow, Manchester, Liverpool, Newcastle-on-Tyne, Northampton, London, Portsmouth and Plymouth are still dependent mainly, if not entirely, upon horse power. The new Blackpool tramway we have described, and it now remains to be seen whether sufficient enterprise is not forthcoming to make electricity indispensable for the economical working of tram lines.

Mr. Gladstone's Birthday.—Amongst numerous other congratulatory telegrams, Mr. Gladstone on his 76th birthday on Tuesday received the following:—"We offer you our heartiest congratulations upon the completion of your 76th birthday, and wish you and yours many happy returns, and pray that God may long spare you to continue to be a power for good.—Edinburgh Liberal Telegraph Clerks."—"Chester telegraphists congratulate Mr. Gladstone on the attainment of his 76th birthday, wishing him many happy returns of the day."—"Heartiest congratulations from the House of Commons and Parliament Street telegraph clerks."—"Glasgow telegraphists unite in forwarding best wishes and heartiest congratulations on 76th birthday, with compliments of the season."

The Supply of Power.—The arrangement made between Messrs. Hornsby and Sons and the Jablochkoff Company for the lighting of Covent Garden Theatre appears to be deserving of more than passing notice. The former supply the latter with horse power, inclusive of engines, fuel, men, and incidental expenses for a given sum per month, the Jablochkoff Company thus being relieved of all responsibility up to the dynamo shafting. Such a compact should certainly be the means of securing both mechanical and electrical engineering of a high order, and this may probably be the reason why so few complaints have been heard respecting the electric lighting of Covent Garden during the season.

A New Light.—The Vienna correspondent of the *Standard* states that experiments are being made, at Professor Lieben's chemical laboratory, with a new gas light invented by Dr. Auer. A cotton wick, saturated with an incombustible metal solution, is introduced into the flame of an ordinary Bunsen lamp, the result being a light similar to the incandescent electric light.

Static Electricity.—"Spark" writes us as follows on this subject:—"Whilst running two Gramme machines for a period of 16 hours (commencing on Tuesday 15th ult., and stopping on Wednesday morning), with new leather belts from same line of shafting, towards morning a beautiful brush discharge was seen to escape to the ends of both machines, and on placing one's hand a good discharge was obtainable at a distance of nine inches. Will any of the readers of your valuable journal say if this is a usual thing, as I have been amongst machinery for a greater part of my life and have not noticed anything of the kind on leather belts before?" Our correspondent's experience must have been an exceptional one, as brush discharges of this kind are matters of every-day occurrence.

A Novel Gas Lighter.—In a well-known engraving and litho-zincographing establishment, where electric lights are largely used for photographing, it is stated that the gas is often lighted by simply holding a piece of wire from a speaking tube to gas burner, or from another gas pipe to gas burner.

The Sixpenny Telegram.—Mr. Geo. Bowes writes to the *Times*:—"If other people find the same inconvenience as I in the receiving of telegrams without the names of the senders of them being given, it is well to draw attention to the fact that much loss of time is caused by the omission. I am continually receiving messages which puzzle me much to find out from whom they emanate. The omission to give the name is no doubt due to the fact that there is no statutory obligation to send it, and there being no place for it in the official form, it is forgotten. To obviate this inconvenience the form of the message should be "From" as well as "To," and it should be made compulsory to give the surname at least. If the inconvenience I have found be general, the Act should be amended, as it is no use receiving sixpenny telegrams if they cost you shillings in time in endeavouring to find out who are the senders of them."

Swearing by Telephone.—The telephone is not an unmixed blessing, as many persons in America and several in Brussels have discovered—the latter recently. The Palace of Locken is in telephonic communication with the Opera House in Brussels, and it appears that her Majesty the Queen of the Belgians was the other day amusing herself by listening through the telephone to a rehearsal of the new opera by Litolff when she suddenly dropped the receiver and retired. The leader of the orchestra, in his anxiety to bring the chorus up to the degree of perfection he considered necessary, used rather strong language, forgetting for the moment that the telephone was present, and his words reached the Royal ears. The Queen made a formal complaint, and now there is much trouble at the Opera House.

The Telephone and the Telegraph.—The Bradford Chamber of Commerce has decided not to support the proposal from Major Shepherd that facilities should be granted for persons connected with telephone exchanges to have messages for any part of the world telephoned through to the postal telegraph offices. The Postal Committee, which had the matter under consideration, would not give its judgment against or in favour of the proposition. In a short time it was possible there might be extensive changes in the telephone, when it would be more reliable than at present, and then there might be a chance of the proposal receiving more attention.

Electric Lighting of Shops in Manchester.—The Manchester Edison Company is lighting Messrs. Paulden's extensive shop in Stretford Road, Manchester, with 300 incandescent lamps, each of 50 candle-power.

Messrs. Hope Brothers, Market Street, Manchester, have had their premises lighted internally with 100 incandescent lamps by Mr. H. Bury, who had previously lighted the exterior with arc lights.

Rochs Ahead!—See the new International Cable Company below.

In the Key of "A moll."—The Continental "Etève" Engine Company, set to the pretty tune of £450,000.

NEW COMPANIES REGISTERED.

International Cable Company, Limited.—Capital £1,000,000 in £10 shares. Objects: To establish telegraphic communication between the Azores, the West Indies, Canada, and the United States, from such point or points on the Coast of Great Britain and Ireland and the Continent of Europe as the company may determine, and between any point or points on the Coast of Canada, the West Indies, the Azores, the Bermudas, Central America, and the South American Pacific Coast, and from any point or points on the Pacific Coast, of Canada or America, to Japan and the Continent of Asia. Signatories (with 1 share each): G. Gordon Leycester Macpherson, 39, Lombard Street; Wm. Pope, 30, Finsbury Circus; E. G. Heathfield, 96 and 97, Palmerston Buildings; J. Jäcker, 1, Manor Park Villas, Streatham; T. H. Craven, 145, Evering Road, Stoke Newington; W. G. Gribbon, Norbiton, Surrey; G. B. Holroyd, Byfleet, Surrey. The signatories are to appoint the first directors, qualification 50 shares, or £500 stock; remuneration, £5,500 per annum. Registered 24th ult. by Bonner Wright Thompson & Co., 165, Fenchurch Street. Registered office, 39, Lombard Street, E.C., Otto Rochs, manager.

Continental "Etève" Engine Company, Limited.—Capital £450,000 in £1 shares. Objects: To purchase certain patented inventions relating to motive power, and to carry on the businesses of mechanical and chemical engineers, manufacturers of engines, workers and dealers in electricity, motive power and light, and any business in which the application of electricity or any other power may be useful. Signatories: A. D. Moll, 15, New Broad Street, 1,000 shares; E. J. Sheriff, 22, York Place, Portman Square, 500 shares; J. Lichfield, 61, Layspring Road, Leytonstone, 300 shares; J. Murphy, Wood Lane, Highgate, 10 shares; E. Fickling, Crouch Hill, N., 25 shares; R. Angus, 69, Holland Road, 300 shares; J. J. R. Humes, C.E., 18, Lilford Road, Camberwell, 200 shares. The signatories are to appoint the first directors, one of whom is to be Mr. Albert Douglas Moll; remuneration £150 per annum for each director, with £100 extra for the chairman. M. Jean André de Braam is appointed resident director in Paris at an additional remuneration of £300 per annum. Registered 29th ult, by Wm. Lichfield, 15, New Broad Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Lancashire and Cheshire Telephonic Exchange Co., Limited.—The annual return of this company, made up to the 3rd September, was filed on the 23rd December. The nominal capital is £300,000 in £1 shares. 296,161 have been allotted and the full amount has been called and paid thereon. Since the date upon which this return was made up, the nominal capital of the company has been increased by the addition thereto of £100,000 in £1 shares.

CITY NOTES, REPORTS, MEETINGS, &c.

Gülcher Electric Light and Power, Company, Limited.

THE fourth ordinary general meeting of this company took place on Wednesday, December 23rd, at the offices of the company, 4, Coleman Street, E.C., Mr. Daniel de Castro, Chairman, presiding.

Mr. Russell Day, the secretary, having read the notice convening the meeting, and the minutes of the previous meeting, which were confirmed,

The Chairman said that on former occasions he had occupied a good deal of time in dealing with the various subjects affecting the company's interests, but the affairs of the company were now in such a position that the directors were able to tell the shareholders almost all they had to say in the report. But there were a few passages in the report which he wished to amplify, and which he thought the shareholders would wish to have explained more in detail. He proposed to run cursorily over the report, and then state a few facts from notes he had made. The first part of the report drew attention to the item of law costs, which was no doubt a serious item in the profit and loss account. At the date of the last-mentioned report serious litigation had commenced between Professor Crookes and the company. The company had brought an action against Professor Crookes for the return of £35,000, the amount of the purchase money for his incandescent lamp patents; and Professor Crookes had retorted by moving in the Chancery Division for a receiver and manager of the company's business. This was immediately followed by two Chancery petitions to wind up the company compulsorily, one presented by Mr. Henry Crookes, the manager of the Incandescent Lamp Department, the other by Mr. Norton, an original director of the company. Both petitions were dismissed, the latter upon the company undertaking to bring an action-at-law against Mr. Norton, which action was of course accordingly brought. In the last report the directors informed the company that the Crookes patents were in their opinion valueless; and that the Incandescent Lamp Department, managed by Mr. Henry Crookes (who drew a salary of £500 per annum), had always been carried on at a considerable loss. The result of the litigation, so far as the Messrs. Crookes were concerned, was that the company reassigned to Professor Crookes his various patents, and gave his son one quarter's salary, viz., £125. On the other hand Professor Crookes surrendered to the company £11,300 in fully paid up shares making (with £10,250 previously surrendered by him) a total surrender of £21,550 in fully paid shares of the company. He also returned £2,000 worth of Six per Cent Debentures, which he had received as part of his purchase money, and surrendered all claims to the position of consulting electrician to the company. It would be seen from the accounts that the result of these transactions appeared in the books of the company as a large loss of assets; the directors, however, considered that a substantial gain had been made. Two-thirds of the £35,000 purchase money, paid for patents which were valueless, had in one way or another been now returned, and the loss of the other third (which accounted for a large proportion of the total deficiency in the company's assets) was incurred by the original board when the contract with Professor Crookes was effected. On the other hand, the return of the £2,000 worth of debentures, and the reduction of the salaries' list by £1,050 per annum, were substantial gains to the company due to the position which, with the shareholders' consent, the board took up last autumn. Moreover, the annual loss incurred in the incandescent lamp department alone was very large indeed, and far exceeded the cost of the litigation which had enabled the directors to shut up that department altogether. With regard to the agreement with the original promoters, it was not yet completed. The company had performed its part, but the promoters had still to surrender about £6,000 worth of fully paid-up shares in order to complete their part. The company had now waited two years to give the promoters every chance of carrying it out, but as no move had been made for some time by the promoters, the company intended, under the advice of counsel, to take immediate steps to enforce the performance of it by them. It would be in the memory of those shareholders who attended the general meeting last December, that a resolution was passed authorising the directors to treat certain sums amounting together to £1,223 15s. 3d. as claims only, and not as debts. These claims were chiefly for fees alleged to be due to the old directors, and for a balance due to their solicitors. With the exception of £164 18s. 2d., claimed by the late chairman as unpaid balance of his fees, and for which he was now sueing the company, all the above claims had been disposed of upon terms considered satisfactory by the directors. The sale and hire of dynamos and lamps during the 12 months ending September 30th, 1885, amounted to £10,099 11s. 8d.. whereas the proportional sale and hire during the preceding 12 months amounted to £7,200, or thereabouts. This scarcely represented the progress which the company's business had made. A considerable increase of business set in towards the end of August last, which was developed throughout September, and had been increasingly maintained since; and the orders in hand at the present moment were quite as large as the company with its present capital could conveniently undertake. There was also a reasonable prospect of a still further increase of business not only in the direction of electric lighting, but of the manufacture of dynamos for the electrolytic deposition of metals, to which branch considerable attention had been given of late. The company had orders from the Government for army and navy purposes, and from all kinds of manufacturing establishments. The most important order perhaps was that of Sir Wm. Armstrong for Elswick works. The adoption by the Elswick Company of the Gülcher Company's system of lighting was a sufficient guarantee in itself of its excellence and efficiency. For the first time since the formation of the company a manufacturing profit could be shown, and although it vanished as compared with the heavy standing and other expenses of the year, it compared favourably with the manufacturing loss which had to be admitted in the last balance sheet. Many of the expenses were exceptional, and were not likely to recur. Exclusive of the charges for depreciation of patents, &c., these expenses ought, in the opinion of the directors, not to exceed £2,500 in the ensuing year. On the other hand, the permanent staff at the works (whose salaries, exceeding £600 per annum, were included in the item "wages" in the manufacturing account) would not be any larger though the business should increase threefold, but assuming that the turnover should only be doubled (which the directors did not think at all improbable) the margin of profit to be carried to the credit of profit and loss would be increased by the addition of £600 from that cause alone. No dividend could be paid until the losses had been made up, and it might therefore become expedient at a future time to reconstruct the company. In conclusion he begged to say that he now resigned the chairmanship of the board, and that there was a seat on the board at the disposal of the proprietors. He retired by rotation, and did not offer himself for re-election, as the onerous nature of the work involved seriously interfered with his professional business. He begged formally to move the adoption of the report and accounts.

Major Cotton seconded the motion.

Mr. Foulsham asked if the company did not manufacture incandescent lamps, how was it that it was erecting incandescent installations?

The Chairman replied that the company supplied Gülcher dynamos and bought and supplied Swan lamps at a profit.

Mr. Murray said he did not quite understand the item of £10,848. He also asked why the manufacturing account and the profit and loss account were kept separate.

The Chairman explained that the accounts had been approved and were drawn up in the usual way by Messrs. William Edwards, Jackson and Browning, F.C.A., and he believed that it was the proper form of account for a manufacturing business.

In answer to a shareholder, the Chairman explained that the arrears on the two last calls amounted to about £2,500. Only a small portion of this amount was considered bad, but certain shares, which were held by persons whose addresses could not be found, would after a time be forfeited unless the arrears were paid.

Mr. Hidden and other shareholders having asked a variety of questions as to calls, and suggested a reconstruction,

The Chairman said that the question of reconstruction had been for some time under the consideration of the board, and that they thought they saw their way to proposing a reconstruction shortly upon the basis of writing off £3 10s. or £4 per share of the capital as lost. If they wrote off £3 10s. per share there would be assets (independently of the value of the Gülcher patents, whatever that might be, and independently of anything for goodwill), more than equivalent to the 30s. per share which would remain paid up. The capital would then consist of £30,000 or thereabouts, for which there would be more than £30,000 worth of stock, plant, material, book debts, cash, and bills. A dividend could then be paid when earned, as all the losses would have been written off, and with a dividend being paid, new capital might be asked for if required. It might perhaps be, and he believed it was, the opinion of some of the shareholders that it would be better to write off £4 than £3 10s., as the shares would still be intrinsically worth the same money; and of course the same sum of money declared as divided on £20,000 capital would be larger and much more attractive than if declared upon £30,000. He agreed to this proposition, but in his opinion it was the duty of the board simply to tell the shareholders what amount would have to be written off in order to make the share capital equal to the value of assets of the company as a going concern; and to do that

it would be sufficient if £3 10s. per share were written off. It would remain, however, for the shareholders when the scheme was ripe and placed before them to decide for themselves whether their shares should thenceforth be 30s. shares or £1 shares only—in each case, of course, fully paid up. Having regard to the large amount of work in hand and in prospect compared with the small amount of working capital at the disposal of the board, it was resolved to authorise the directors to raise, as they might require it, a sum not exceeding £5,000 by the issue of debentures. Part of this was offered by shareholders present, and he had no doubt from his knowledge of the body of shareholders that that sum could be easily raised among them—in fact, more easily than £10,000 which had been raised two years ago, and since paid off.

The report and accounts were then unanimously adopted, and Messrs. Mountain and Fricker were re-elected directors.

The Chairman said, in answer to questions from one or two shareholders, that it had been his intention to retire from the board at this meeting and to decline re-election, as he considered that he had practically finished the work which he undertook to do two years ago, and he thought that the company could now go on very well without him. He had, however, received so many and such pressing requests from shareholders not to retire at present that he felt constrained to comply so far as he could with their wishes. If, therefore, the general body of shareholders thought that his work was not yet completely finished, he would consent to be elected once more, and he, therefore, placed himself in their hands and at their disposal.

Mr. Foulsham moved, and Mr. Woodly seconded, Mr. De Castro's re-election, and this was unanimously carried.

Messrs. Wm. Edwards, Jackson, and Browning, the auditors, were re-elected, and a cordial vote of thanks to the chairman and directors then terminated the proceedings.

Eastern and South African Telegraph Company, Limited.—This company announces that the coupons due on January 1st on its 5 per cent. mortgage debentures, will be paid on presentation at the offices of Messrs. Barclay, Bevan & Co.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 25th were £2,052, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1885.

15455. "Dynamo-electric machines." J. C. MEWBURN. (Communicated by W. Main.) Dated December 16. (*Complete.*)

15484. "Electricity." J. SWINBURNE. Dated December 17.

15535. "Dynamo-electric machines." R. P. SELLON, J. S. SELLON. Dated December 17.

15539. "Telephone transmitters." C. E. ALLEN. Dated December 18. (*Complete.*)

15558. "Electric bell circuits and indicators." H. M. TOWNSEND. Dated December 18.

15559. "Electric bell pushes, pulls, and similar contacts." H. M. TOWNSEND. Dated December 18.

15617. "Electrical switches." H. B. BOURNE, H. R. F. BOURNE. Dated December 19. (*Complete.*)

15652. "Apparatus for obtaining rotary motion from electric currents." E. O. WEHRLE. Dated December 19.

15658. "Electrical switches." B. M. DRAKE, J. M. GORHAM. Dated December 19.

15674. "Secondary batteries, or electrical accumulators." P. HIGGS. Dated December 21.

15714. "Galvanic batteries." A. R. UPWARD, C. PRIDHAM. Dated December 21.

15817. "Apparatus for transmitting articulate speech or other sounds by electricity." A. F. ST. GEORGE. Dated December 23.

15869. "Primary battery." V. BLUMBERG, A. BLUMBERG, N. FREERE. Dated December 24.

15926. "Electrical toys." J. H. GALLOWAY, W. BANKS. Dated December 28.

15956. "Electric batteries and apparatus." W. S. WHITTER. Dated December 29.

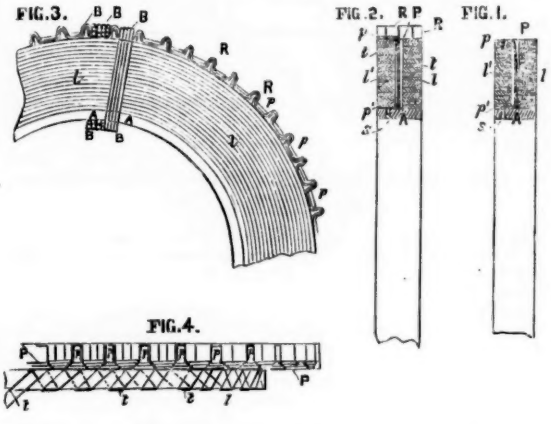
15967. "Electric transmitting telephones." J. T. DEMPSTER. Dated December 29.

15987. "Pneumatic cash carriers." W. G. DAVIS, W. M. HINMAN. Dated December 29. (*Complete.*)

15988. "Electrolytically refining copper and making sulphuric acid by electrolytic action." W. ELMORE, A. S. ELMORE, H. BARRETT. Dated December 29.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

13810. "Improvements in the construction of armatures for dynamo-electric machines." F. WYNNE and R. P. SELLON. Dated October 18. 6d. In figs. 1, 2, 3 and 4, A shows the foundation ring, which is fastened in any suitable manner to the driving shaft; l, l^1, show two spiral cylinders of iron strip wound upon the "foundation ring," between which the disc, P, is placed, this disc is corrugated, and the internal periphery is bent over at right angles at the point, p^1, and rigidly fixed to the "foundation ring," A, by means of suitable screws or rivets, s; the outer periphery is also slotted and bent over at the point, p, alternate flanges



of the disc holding down the two spirals, l and l^1. In figs. 2 and 4, the iron strip, l, is shown served with paper, tape, or other convenient insulating material, t, t, one of the spirals being here shown in course of winding. The corrugations of the disc, P, and the positions occupied by the bent flanges, p, p, holding down the iron strip, are here clearly shown. In figs. 2 and 3, the projecting portions, B, B, B, are also shown, surrounding on the outer periphery, the spiral cylinders, l and l^1, and forming a support for the wire bobbins, B.

13879. "Improvements in the construction and working of electric accumulators, and in apparatus or means therefor." J. S. WILLIAMS. Dated October 20. 1s. 3d. By means of the improvements the inventor increases the storage capacity, reduces the weight and bulk, obviates local action and short circuiting and the destruction or oxidation of the terminals or connections of the elements or the displacement of them, also the destruction of the diaphragms or supports for separating or maintaining the active elements in their proper relative positions.

1885.

311. "Improvements in electric telegraphic apparatus for transmitting and receiving signals on board ship or other places." J. S. GISBORNE. Dated January 9. 8d. Consists of a transmitter having the required orders indicated on a dial, which transmitter is connected by an electric cable with an indicator having also on a dial corresponding orders to those on the transmitter. This cable contains a separate wire for every "order" also a wire common to any one of the "orders" of the series for completing the circuit between the transmitter, indicator, and battery, also a wire connected with the reply gong in the transmitter.

376. "An improved electric annunciator." F. WALKER. Dated January 10. 8d. The inventor employs a weight, which being held in a given position, causes the electric circuit connecting the bell with the annunciator to be broken; and, upon said weight being released, it resumes its normal position, and making electrical contact, rings the bell in connection with the annunciating device or contrivance aforesaid.

597. "Improvements in apparatus or appliances for connecting telegraph cables between ships and the shore or themselves." R. ATKIN. Dated January 15. 8d. The inventor employs a hollow protecting tube for the telegraph or telephone cable to pass through. This tube may lead to the mast head or be fitted to the bows. When it is fitted to the mast, the inventor makes the mast proper tubular and steps it on the between deck beams; within this tubular or hollow mast he places another tubular mast which is stepped and free to rotate on a spindle secured to the kelson of the ship, above the spindle and free to turn with the inner mast there is a platform to carry a winch for the cable, telegraph apparatus, instruments and the like necessary appliances. A convenient distance above the platform there is an aperture in the rotating mast through which the cable passes and is carried up through the tube to the top thereof where it is carried round or through a sheave and thence to the shore, ship, or other place with which it is desired to make communication.

1101. "Improvements in telephonic and telegraphic apparatus." J. STEPHEN. Dated January 26. 8d. Has for its object to provide a switch table which may either be operated by an attendant at the central station or exchange, or automatically by the subscribers themselves.

1184. "Improvements in the regulation of electrical circuits and in appliances connected therewith." D. L. SALOMONS. Dated January 27. 8d. Consists in the introduction, as a regulator, of an electrical motor, or electro-dynamo machine, employed as a motor or as a generator developing a counter current between the forward and return "leads" or wires of a main working circuit, or as it is usually termed "in parallel."

6206. "Improvements in telephone transmitters." A. M. CLARK. (Communicated from abroad by the Long Distance Telephone Company (Incorporated), of New York.) Dated May 20. 4d. The object of the invention is to provide a light portable telephone transmitter which may be readily held in the hand while carrying on telephonic communication. Fig. 1 is a front elevation of the improved telephone transmitter. Fig. 2 is a longitudinal section of the same. Fig. 3 is a transverse section taken on line *x*, *x*, in fig. 2. The invention consists essentially in a granulated semi-conductor, such as granulated or coarsely powdered carbon, maintained normally under compression; also in apparatus for utilising such a semi-conductor in a transmitting telephone. The telephone has a diaphragm cell, I, provided with a mouth piece, J, of the usual form, which clamps the diaphragm, K, in the cell. In the centre of the diaphragm cell is formed a cylindrical cavity, L, in which is placed an elastic rubber tube, M, having at opposite ends the conducting plates, N, N^1, which together with the said elastic tube, M, forms a chamber, O, which is filled with granulated carbon. In the body of the diaphragm cell, I, at diametrically opposite points are placed metallic nuts, P, P^1, which are in electrical communication with the plates, N, N^1, and which receive the pivotal screws, Q, Q^1, passing through spring arms, R, R^1, attached to the handle, S, and form the pivotal support of the transmitter as well as the electrodes by which the current is introduced into the instrument. The diaphragm, K, carries a stud, *n*, which presses upon the centre of the conducting plate, N, and in a cavity formed in the back of the diaphragm cell, I, is secured a cross bar, *o*, provided with a central adjusting screw, *p*, which bears upon the centre of the conducting plate, N^1, and is employed to maintain or vary the normal pressure upon the granulated carbon contained in the elastic tube, M. The handle, S, of the telephone transmitter is made tubular to receive the double conductor, T, containing the wires, *m*, m^1, communicating with the curved arms, R, R^1. The current arrives at the granulated carbon contained in the elastic cell, M, from one pole of a battery, U, through the wire, m^1, curved arm, R^1, screw, Q^1, and nut, P^1, wire, *q*, and plate, N^1, and passes from thence through the plate, N, wire, *r*, nut, P, screw, Q, arm, R, and wire conductor, *m*, to the primary wire of the induction coil, V, which is connected with the remaining pole of the battery; one end of the secondary wire of the coil goes to the ground, the other end being connected with the line. Sounds made in the vicinity of the mouth piece, J, vibrate the diaphragm, K, and the diaphragm acting through the stud, *n*, exerts a greater or less pressure upon the granulated carbon contained in the elastic cell, thus altering its conductivity and producing fluctuations in the current by which speech is transmitted along the line.

FIG. 1.

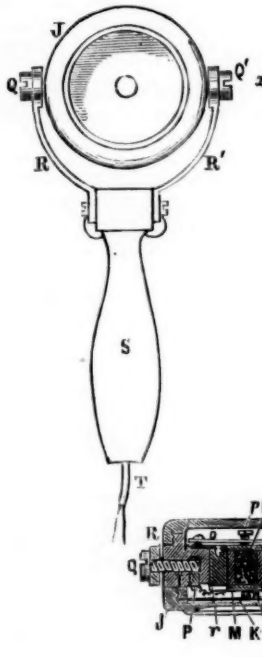
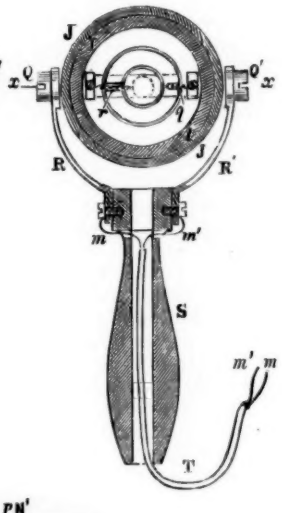


FIG. 2.



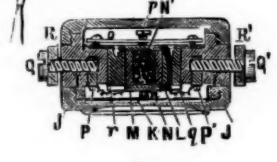


FIG. 3.

CORRESPONDENCE.

Secondary Battery Patents.

Our attention has been called to a paragraph in your issue of 19th ult., relating to the action which was brought by this company against Elwell-Parker, Limited, in Vice-Chancellor Bacon's Court for the infringement of a portion of one of Mr. Sellon's patents which is the property of this company, and also to an advertisement of Elwell-Parker, Limited; and as the public may form an erroneous impression from these publications we write to say that the above action was settled by Elwell-Parker, Limited, consenting to a perpetual injunction and taking a license to manufacture (subject to certain limitations) accumulators under the patents of the Electrical Power Storage Company on payment of royalty; a reciprocal arrangement also existing for the Electrical Power Storage Company to use, under royalty, should they at any time so desire, the Elwell-Parker patent.

Electrical Power Storage Company, Limited.
H. PELL, *Secretary.*

December 23rd, 1885.

A Curious Contact.

Apropos of the paragraph in your "Notes" columns entitled a "Curious Disconnection," it may be interesting or, to say the least, amusing, if we relate the cause of a fault which has within the last few days come under our notice.

The proprietors of one of our largest hotels here called us in to elucidate a mystery which had sorely perplexed the entire staff. The trouble which they complained of was that the indicators belonging to two of the bedrooms were continually dropping and the bell therefore an intolerable nuisance.

On examination it was found that the line wires and return connecting these two rooms passed together through one of the rooms and as the boarding in one part evidently had been difficult to remove it was plain that resort had been had to the gimlet and the wires then threaded longitudinally through that section.

Now it so happened that one of the bedstead legs stood on this identical board and this particular leg for some reason, perhaps best known to itself, having lost its castor, it will readily be imagined that the weight and moving about of the bedstead caused the ragged bolt to break through the *thin* wooden covering which the boring had left. Having broken through the wood and reached the wires, the G. P. covering soon became defunct and the sequel will be at once obvious to your readers.

C. W. and A. E. Cotterell.

Birmingham, *December 29th*, 1885.

Archimedes Redivivus.

There once did lay without the walls of modern Syracuse,
A tramcar, worn and shaky by long continued use;
Archimedes saw in it a means of using force
Extracted from the elements, thus dispensing with the horse;
"The power is small," the sage explained, "it matters not to me,
With a system of my levers I will double it, you see,
And so defy all Nature's laws, and scientific men
Shall hide in very shame their heads, and throw away the pen.
Upon my spindle, four horse-power; thro' my lever, eight;
Sixteen on the axle, when the speed's at lowest rate;
I don't admit the friction, weight, nor wear and tear,
For traction up an incline I have no need to care;
I may confidently tell you, thro' the scientific press,
That before I 'LEAVE HER' I shall score a great success."

Hiero.

Re Electrical Formulæ.

In reply to the remarks of December 19th, signed "Gnan," on the figure 13·59 used by me as Dr. Matthiessen's for the resistance in B. A. units of one mile of pure annealed copper wire $\frac{1}{16}$th inch diameter, 15·5° C., I beg to say that I took it from Clark and Sabine (pages 7 and 8, Jenkins's Table of Standards). Having now looked through a number of authorities I find a majority of statements of Matthiessen's standard in accordance with the correspondent's (f. i., Culley, Kempe, Munro and Jamieson) curiously enough in each case different temperature and dimensions used. I remark that Kohlrausch (1881) quotes Matthiessen with a still lower figure than the above; also that a table published, I think, in 1884, by *The Electrician*, of the Board of Trade wire gauge, has been worked out on the basis of the 13·59 being Matthiessen's figure.

Assuming that my standard figure is too low by the amount in question, then my table of κ and the various figures derived therefrom throughout my articles correspond to copper of 97 (or nearest 97·2) instead of 95 per cent. conductivity.

F. V. Andersen.

I realise with pleasure from Mr. Moon's last article great progress in our discussion. It has hitherto been exceedingly difficult to find a connection between Mr. Moon's remarks and their subject—my paper "On some practical electrical formulæ." He has never tried to prove that any of the formulæ were wrong, and yet he has some objections to their use, and spends column after column in trying to show that there should be something wrong in the matter somewhere; something which he has not yet himself got hold of, but which he evidently believes must turn up by-and-bye, if we only continue long enough to get everything tried. He will not understand that by striking at the wrong formula he can finish the matter in a few lines, whereas by loose assertions, not supported by facts or proofs, he will never shake an $\frac{a}{b} = c$. Last week's contribution, however, marks an improvement; Mr. Moon makes an indirect attack on my formula for electrical merit of dynamos, saying that it will introduce the absurdity that in a certain case, which (alas!) he does not specify, "the figure of merit is increased by making the machine less efficient and less economical." This declaration I welcome as *le commencement de la fin* of my discussion with Mr. Moon. The formulæ in my paper having been established by ordinary algebraic reasoning, I will now ask Mr. Moon to, in a similar way, prove that any one of them is wrong, or that something contradictory is correct. For if formulæ IV., VI., and VIII. in my paper are correct, then it is a physical impossibility that a case such as the one Mr. Moon alludes to can exist.

To go through a communication from Mr. Moon for once, I shall now quote his last statements one by one, and add a brief remark to each.

1. "It is useless for Mr. Andersen to plead that his formulæ are for use *only* in the construction of dynamos."

The small word in italics is Mr. Moon's.

2. "From the preceding it is obvious that Mr. Andersen then proposed to use this particular quality of dynamos as a general criterion by which the values of machines of different types might be determined."

Insert between "values" and "of": "in regard to electro-magnetic construction," and the statement will be fairly correct.

3. "But is it at all probable that dynamo makers will consent to have their machines valued by this one quality alone?"

I will leave to Mr. Moon or the readers to establish a connection between a coefficient of electrical merit and the consent of the dynamo makers, and remark that we might strike out the word "alone," since we ought certainly to test also the mechanical merit, ask the price, and several other little items. At the present time there might, indeed, be makers who would have no objection to know the electrical merit of their dynamo.

4. "The fact that $\text{F} \frac{w\,a}{w\,a + w\,m}$ of a machine was large would neither ensure that it would perform work cheaply nor that it was reliable."

Read the remark against "alone" in the preceding; then, will Mr. Moon kindly illustrate this statement with an example?

5. "His" (Mr. Andersen's) "expression $\text{F} \frac{w\,a}{w\,a + w\,m}$ would be a maximum with a small armature moving in a strong magnetic field, and performing little or no external work."

The size of the armature cannot be inferred from the expression; the "little or no external work" is a fallacy, as a glance at the expression itself will show to anybody who is familiar with the theories of dynamos. Will Mr. Moon kindly give an example?

6. "Several of the recent and most efficient machines rely upon a weaker field and a comparatively large armature."

Hard to say: the hope of these dynamos, for high efficiency is built upon sand, for the proportionate waste in the armature equals $\frac{\kappa\,a}{\text{F}\,\text{V}}$ (κ = ohms × $\frac{\text{section}}{\text{length}}$ of conductor, a = ampères per square inch do., V = velocity). If Mr. Moon by "large armature" indicates comparatively high velocity, this has nothing to do with the point in question. But there is just a tendency to work the modern dynamo at moderate velocity. It must, therefore, rely on a *strong field*, both for power and efficiency.

7. "I must again insist that machines of different types must perform work at the same rate while their comparative values are being determined."

We should wrong the makers by such a way of proceeding. Some machines would burn down while others were running with half their normal load. The rule must be as I have said in my paper, to load all machines so that they perform work at a standard (maximum, safe) temperature.

8. "In this case the figure of merit is increased by making the machine less efficient and less economical."

A description of such a case is required.

9. "To me it is evident that there is a certain proportion between the strength of field and the amount of conductor on the armature which would produce the most economical result, and that either an increase or a decrease of the effective strength of field would produce a result less economical."

It is quite evident to me that this theory as it stands expresses an absurdity. Draw a comparison between a dynamo and a galvanic battery: What is the maximum economical electromotive force per couple of electrodes, other things being equal?

10. "This term" (figure of merit) "in telegraphy refers to sensibility, and not to efficiency or economic value."

A glorious distinction. Does Mr. Moon want this argument taken seriously?

In conclusion, I remark that I have undertaken the task of analysing the whole of one of Mr. Moon's letters, on purpose to relieve myself of the duty of further discussing with him the present subject in general, as I think it will now be evident to the readers what a waste of energy that means.

Only in case he takes to facts shall I again take notice of his remarks. In criticising the conclusions to be drawn from formulæ for use in practice, he appears to me to work too much like one of those recent dynamos which rely upon a weak field and a large armature, *i.e.*, on lack of force and abundance of matter, which cannot be efficient.

F. V. Andersen.

December 28th, 1885.